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ABSTRACT

The four chapters in this resource book provide general considerations for the development of teacher-made achievement tests in science for students with visual, hearing, and/or orthopedic impairments. Chapter 1 focuses on changes in classroom testing by considering the testing of handicapped students, norm-referenced versus criterion-referenced testing, individualized educational planning, and the science test. Chapter 2 discusses the testing of visually impaired students. Topic areas addressed include: determining an appropriate testing technique; visual, auditory, and tactile testing techniques; student response to test questions; laboratory type tests; and non-teacher made tests. Chapter 3 discusses the testing of hearing impaired students, examining language considerations, item format, test administration, and non-verbal tests. Chapter 4 focuses primarily on facilitative techniques for testing motor impaired and orthopedically disabled (MIOD) students. Areas addressed include the breadth of the problem, the need to assess life function impairment (with a sample assessment included), administration techniques, accessibility, time factors, and possible mitigative testing strategies (listed according to MIOD limitation). A list of references, a list of organizations and agencies for the disabled, and glossary are provided in appendices. (JN)

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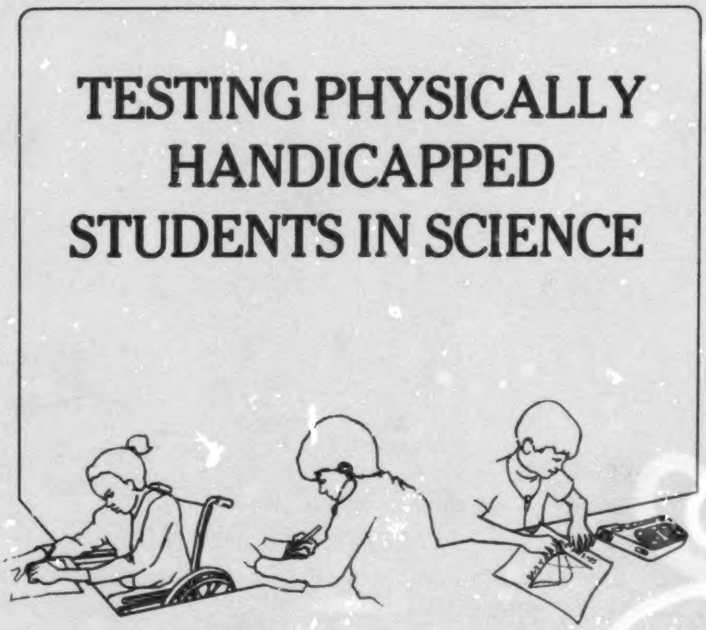

A RESOURCE BOOK FOR TEACHERS

Dean R. Brown
E.C. Keller, Jr.
Harry G. Lang
Kenneth R. Ricker

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This book is dedicated to my father-in-law, Eddie Meath, who brought love and happiness into the lives of thousands of handicapped children.

Harry G. Lang

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PREFACE

One problem that has not been adequately addressed in the literature on science teaching is the issue of teacher-made achievement tests. Science teachers often have little or no training in test construction and validation techniques. If they are lucky, a school psychometrician may be available for assisting with the development of valid and reliable classroom tests. Yet even the most skilled testing specialists frequently lack an understanding of the special needs of physically handicapped students. The determinants, concomitants, and effects of a physical disability may confound the test results, severely limiting the interpretation of test scores. Moreover, parents and handicapped students now have due process rights to assure that tests or testing conditions are not discriminatory.

Under a contract for the Office for Civil Rights (OCR), the National Research Council (NRC) assessed OCR's Section 504 regulatory treatment of standardized testing of handicapped students and employees in higher education. Its report, Ability Testing of Handicapped People: Dilemma for Government, Science, and the Public (National Academy Press, 1982, 203 pp.), concludes that current testing practice does not allow full compliance with the regulations as they are currently drafted. The NRC Panel on Testing Handicapped People recommends a four year research program to further investigate the issue of standardized testing.

Recognizing a similar problem with teacher-developed classroom tests, a Committee on Testing and Evaluating Physically Handicapped Students in Science was formed in early 1979 to identify specific problems encountered by physically handicapped students when taking science tests and to offer some suggestions for remediating the problems. The committee was made up of four members of the Science for the Handicapped Association, which is associated with the National Science Teachers Association. The following chapters provide general considerations for the development of teacher-made achievement tests in science for students with visual, hearing, and/or orthopedic impairments. Specific suggestions for constructing and administering science tests to physically handicapped students are presented. In addition, we have included a glossary of some important terms to assist those reader's not familiar with the content. We hope that the following pages will assist science teachers in developing an appropriate testing environment for their classroom, one free of discrimination, and one which sets the stage for valid assessment of achievement of all students in the science classroom.

THE AUTHORS

Dean R. Brown received his bachelor and master's degrees from the University of Nebraska in Omaha. Both degrees were in the Biological Sciences in addition to meeting certification requirements for teaching. He was a science instructor in the junior and senior high schools in Omaha, and taught science and math overseas with the Air Force. He completed a doctorate at the University of Georgia in the areas of Microbiology and Science Education. Dr. Brown taught at the University of Georgia for several years, and recently has been a professor of Science and Handicapped Education at Colorado State University in Fort Collins, Colorado. Since taking a sabbatical leave in 1977-78 to study various areas of handicapping, Dean Brown has been primarily involved in the instruction of mainstreamed handicapped junior high students in the Fort Collins school system. He has been directing projects for adapting science materials for students in grades 7-9 who are handicapped, and especially those students who are deaf or hard of hearing. His prospective science teachers from the universities are given "on the job training" with mainstreamed classes to better prepare them for teaching. Dr. Brown has published articles on mainstreaming and was the President of the Science for the Handicapped Association in 1980-1981.

E.C. Keller, Jr. is a Professor of Biology at West Virginia University in Morgantown. Dr. Keller is a post-polio paraplegic. He was the co-founder and is presently the secretary of the Foundation for Science and the Handicapped. He also serves as the Chairman of the Committee on the Handicapped of the National Marine Education Association, is the director of several NSF projects on marine science for physically handicapped students and is a proposal reviewer for many governmental agencies on projects concerning the handicapped. He was a delegate to the White House Conference on Handicapped Individuals and an editor for some of the papers for that conference. He was awarded an honorary Doctor of Science degree from Salem College for his work with the physically disabled. He is active in local and regional projects on the disabled and works with the West Virginia Commission on Disabled Persons. He has just completed a two-year term as Vice President for the Handicapped United of West Virginia coalition. Dr. Keller has published over 160 papers, abstracts, reviews, and manuals. In addition, he has written numerous reports and analyses for governmental and industrial groups. He is currently editor of The Proceedings of the West Virginia Academy of Science as well as editor of a book on mainstreaming physically disabled students in science.

Harry G. Lang is an Associate Professor and Staff Chairperson in the physics program at the National Technical Institute for the Deaf in Rochester, New York. Profoundly deaf himself, he has been an active member of the Special Education Committee of the National Science Teachers Association and is President of the Science for the Handicapped Association. He is also President of the Special Interest Group in Science Education within the Convention of American Instructors of the Deaf. Dr. Lang is a trainer in the National Project on Career Education and has published and presented numerous papers on career education and science education for hearing impaired students.

His interest in classroom testing began eleven years ago while developing a Learning Center approach to teaching college physics. Through one-on-one interaction with his students, he noticed that they were learning much more abstract physics concepts than they were able to show through test performance. This concern with the language dimensions of testing ultimately led to his establishment and chairing of the Committee on Testing and Evaluating Physically Handicapped Students in Science.

Kenneth R. Ricker is an Associate Professor of Science Education at the University of Georgia. Throughout his professional career he has had a particular interest in the education of students with special learning needs. He has served as President of the Science for the Handicapped Association and a Director of the Foundation for Science and the Handicapped. Dr. Ricker is co-editor of the *Sourcebook: Science Education and the Physically Handicapped*. As a legally blind person he has a special concern for teaching science to visually impaired students. He has published and presented numerous papers on this topic. Dr. Ricker was the recipient of the 1981 NSTA -Ohaus Award for Innovations in College Science Teaching as a result of his work on teaching biology to visually impaired students.

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The authors invite the readers of this book to suggest revisions or additions. The text will be revised based on feedback from readers before the next printing. Send your comments to:

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CHAPTER 1

CLASSROOM TESTING: A CHANGING PARADIGM

Harry G. Lang
Dean R. Brown

CHAPTER 1

CLASSROOM TESTING: A CHANGING PARADIGM

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Introduction

There has been a growing discontent with traditional measurement and evaluation procedures, especially over the past decade. This discontent has been evident in the literature. A complete re-evaluation of the whole structure of testing in our society has been repeatedly called for (e.g., see Tyler, 1973). The National Education Association Task Force on Testing (1975), formed after 8000 delegates passed several resolutions calling for a total testing moratorium, reported to the fifty-fourth representative assembly that group standardized intelligence, aptitude, and achievement tests used to assess student potential or achievement are in need of extensive appraisal and revision.

The recognition of the inadequacies of normative evaluation procedures for many educational assessment purposes is not limited to professional organizations. Those involved directly with instructional systems and curriculum development are also concerned. Benjamin Bloom (1968) writes:

> Each teacher begins a new term (or course) with the expectation that a third of his students will adequately learn what he has to teach. He expects about a third ... to fail or to just 'get by'. Finally he expects another third to learn a great deal ... but not enough to be regarded as 'good students'. These expectations are transmitted to students through the practice of grading. The system creates a self-fulfilling prophecy such that the final sorting of students through the grading process becomes approximately equivalent to the original expectations. (p. 1)

Bloom has for years been a leader in developing new instructional systems based on mastery learning in which instructional strategies are adapted to the needs of learners. The rapid growth in individualized instruction and mastery learning systems has served to fuel the fire of discontent with classical measurement procedures used in evaluating performance and achievement in the classroom. Although teachers within particular curricula continue as the principal evaluators and decision-makers regarding student achievement and progress, suggestions regarding evaluation are frequently offered from outside the classroom. These recommendations range from comprehensive theoretical models for evaluation to specific instruments for assessment of learning. Commercially-produced tests, contract testing, and profiled reports from publishers have become the vogue over the past decade. Despite the availability of such services, teachers often develop their own evaluation instruments, even though a majority of them have had little or no prior training in the design of valid and reliable tests, appropriate administration procedures, or interpretation of test results.

Compounding this dilemma is the increasing student disenchantment with mandated programs of instruction and with the assessment of the results they produce. Rubin (1977) writes that where social inequities etch deeply into the school environment, students are often rebellious and alienated. Even those with a comparatively more privileged background (residents of affluent suburbs, for example) are dissatisfied. Rubin's discussion of the moral outrage of many students over grades based upon competitive achievement reflects discontent with conventions and tradition, including the fundamental question of the value and methodology of grading.

Testing Handicapped Students

While these problems are shared by all educators, those teachers with handicapped students in the classroom face an even more serious dilemma. Evaluation instruments and procedures may be "discriminatory" if they do not provide equitable conditions for valid assessment. The American College Testing (ACT) Program (N.E.A., 1978) reports that in each of several recent years 11,000 of the 1,000,000 test-takers require some accommodation because of a handicapping condition. Only 1,000 take the ACT in a modified form. The Educational Testing Service (ETS) reports that in 1978-79, 2,500 of their 1,000,000 test-takers took the Scholastic Aptitude Test in modified form (ETS, 1980). There is no record of the number of handicapped persons who took the SAT under standard conditions.

Handicapped students being tested in the classroom will have similar expectations for achievement and similar test anxieties as non-handicapped students. But if the fact that the handicapped student may have different needs in a testing situation is overlooked, the teacher runs the risk of denying that student the right to compete on an equal basis and, hence, the opportunity to achieve an appropriate score on the test (Robinson, 1979). In the case of criterion-referenced testing, failure to recognize special needs during testing may result in test scores which do not accurately reflect the handicapped student's mastery of the course content. In many cases, minor adjustments in testing techniques and methods can lessen this risk and make the testing more effective.

Teachers need to focus on the fact that quite simply, a handicap is a disadvantage that makes both achievement and the demonstration of achievement on classroom tests difficult. Seen in this way, we may well ask which of our students or which of us, for that matter, is not handicapped.

Teachers cannot dichotomize students as those who are handicapped and those who are not. Yet for educators, such a categorization is tempting. One group of students could be assigned to traditionally trained classroom teachers, the other to teachers specially trained to optimize the education of handicapped children. Such an arrangement would be even more impractical than it is illogical. Neither the local school districts, nor the state education agencies nor the Federal government have the resources to implement such a plan.

Adaptations for testing handicapped students require an awareness of the ramifications of a variety of handicapping conditions as well as considerable sophistication in test development. The challenge for the classroom teacher becomes one of reconciling student needs with available testing technology.

Norm-Referenced vs. Criterion-Referenced Testing

Historically, performance evaluation within the classroom has been controversial. For half a century, norm-referenced tests were used as instruments for sorting and spreading students out according to relative measures of ability. Items were written to identify differences among individuals. Test constructors strived to maximize variance in the test score distribution in order to accomplish that purpose.

As early as 1963, Glaser recognized the inappropriateness of the traditional norm-referenced notions and described the fundamental difference between norm-referenced measurement and criterion-referenced measurement in an article responsible for the growth of interest in the criterion-referenced measurement issue over the past decade. Cronbach and Gleser (1965) and Popham and Husek (1969) also questioned the usefulness of classical test theory for all testing problems. The latter write that the design of any test must obviously be responsive to the purpose and objectives in developing the instrument.

Criterion-referenced tests provide absolute measures of student ability. Whereas a norm-referenced test will tell us how well a student is performing with respect to others taking the test, a criterion-referenced test provides information on what a student knows or doesn't know. Criterion-referenced test items are carefully developed to diagnose an individual student's strengths and weaknesses with respect to a domain of objectives or skills (i.e., the criterion). In this sense, it is highly applicable to the concept of individualized educational planning.

Trump (1974) summarized well the attitude of many educators regarding individual differences and classroom evaluation:

> If we believe in individualized learning, then individualized evaluation is axiomatic. The first ... practice to abandon is the constant comparison of the individual with other pupils in whatever group he happens to be in (sic) at the moment. Instead, the evaluation to be emphasized is the individual pupil's progress or lack of it. The comparisons needed are between what the individual is doing or knows today as related to comparable accomplishments earlier ... a month, six months or a larger period. Comparing an individual pupil with others in his group may give the top pupils a false sense of security; it is almost certain to give the bottom pupils a continuing sense of frustration and defeat. (p. 13)

Establishing norms and testing and evaluating students according to the differences observed among them has long been the core of evaluation in schools in our country. There are a number of limitations to using norm- referenced testing schemes, however, especially when decisions regarding student "ability" will be made based on these tests. Rosner (1975) writes that each device is useful and specifically appropriate for certain applications. Norm-referenced test data are useful, for example, when information is needed about the relative performance of individuals or groups of individuals in order to make programmatic decisions. For daily instructional activities, e.g., in many individual-oriented decisions, criterion-referenced test data may be more appropriate.

Martuza (1977) writes:

> When there is a choice available regarding test score interpretation ... the use to which the scores are to be put should be the primary factor in deciding which of the two frameworks ought to be adopted for test construction and test score interpretation. If, for example, the purpose for testing is simply to rank-order the examinees along some achievement continuum ... a norm-referenced orientation seems appropriate; on the other hand, if the test scores are to be used as a basis for deciding whether to prescribe remedial work in a given content or skill area, or to pass the student along to the next unit in an instructional sequence, a criterion-referenced orientation would appear to be more appropriate. (p. 7)

No matter which model is used, the tests must be reliable. Martuza describes the effects of basing decisions on the results of unreliable tests. If an individual is incorrectly retained for remedial instruction, progress will be retarded and side effects such as boredom, disenchantment with content or curriculum, or a profound distrust of the evaluation procedures may result. Passing a student on before a satisfactory level of achievement has been reached may also cause considerable frustration of an opposing nature.

Reliable and valid assessment tools are crucial to the evaluative decision-making which occurs daily in our schools (Lang, 1982). Teachers, as decision-makers, are responsible for evaluating the achievement and monitoring the development of students in their classes. The integration of handicapped students will place an even greater evaluation burden on the shoulders of these classroom teachers.

It is also important that testing be integrated into the instructional system. For criterion-referenced tests, in particular, Rosner (1975) believes the full potential of testing is realized only when it is part of the day-to-day functioning of the classroom. Glaser (1973) states this point optimistically:

> In the near future, testing will not stand out as an extrinsic, external adjunct of instruction; it will become an integral part of the educational process itself.

Individualized Educational Planning

The present thrust, in accordance with Public Law 94-142, is toward the use of "Individualized Education Programs." Teachers, counselors, and resource personnel are required to write objectives for each handicapped student as part of the IEP development. PL 94-142 mandates that the individualized education program be developed for every handicapped student at no cost to the parents. The IEP is regarded as the heart of the law (Rosen, Skinski, and Pimental, 1976). The IEP must include a statement of the student's present level of academic performance, annual goals, short-term instructional objectives, specific educational services to be provided, and the extent to which the student will be able to participate in regular educational programs (Deninger, Cowan, and Rosen 1976; Lovitt, 1977). In addition, it must project a date for the initiation of the services and their anticipated duration. Appropriate procedures must be used to determine, at least on an annual basis, whether or not the instructional objectives are being achieved.

The lack of adequate details on evaluation procedures has caused chaotic conditions during the first few years that PL 94-142 has been in effect, disillusioning many teachers, counselors, and resource personnel.

The evaluation of a student's educational needs should be performedby a multidisciplinary team, including at least one teacher or specialist with knowledge about the student's handicap. Typically, members of this team should be the student's classroom teachers, parents, specialists when necessary, and the student, when appropriate.

Since the law mandates that regular classroom teachers be a part of such an evaluation team, one clear interpretation is that the assessment process is not to be regarded in isolation from the education program. LeNard and Trybus (1976) write:

> The emphasis is on the need for educational data, not just intelligence measures. The areas identified for the content of the IEP are more reflective of educational programming ... Tests are generally developed by specialists, not educators,

> and, vice versa, educators generally develop curricula and instructional materials. Too often the gap can be widened by the jargon of the two separate disciplines. The gap between these two must be successfully bridged. The IEP could be this bridge. (p. 7)

A student's needs must be evaluated in all areas related to the handicapping condition. This includes such factors as health, vision, hearing, social and emotional development, general intelligence, academic performance, ability to communicate and motor (physical coordination) ability.

PL 94-142 implies that diagnosis, measurement, and progress evaluation will be systematically conducted for each handicapped student. PL 94-142 spells out some key provisions about testing. Tests must be racially and culturally unbiased and must be given in the native language and "primary mode of communication" of the child (Guidulbaldi, Kehle, and Murray, 1979). If a child speaks Spanish at home, he should be tested in Spanish. It is not adequate to merely translate the English language test. The items should be written, but in terms the student understands. When necessary, interpreters should be provided for deaf students. Some visually handicapped children need large print, others may do better with braille or tape-recorded tests or readers. Long tests should be administered over several shorter periods of testing for children who have trouble sitting still or concentrating for long periods of time. The individual needs of each student should be determined prior to the testing date.

No single procedure should be used as the sole criterion for determining an appropriate educational program for a student (Gearhart and Weishahn, 1976). In many cases the school psychologist and/or educational diagnostician will be responsible for some of the testing which will help determine the handicapped student's course of study. It is essential that the classroom teacher be involved in a melding of instruction and appraisal. Individualized education programs have required the development of objectives to be fulfilled by the student in each class in which he/she is enrolled. Vague guidelines on the breadth and scope of such objectives have caused difficulty in evaluation.

Pyfer (1976) writes that to ensure quality of instruction for handicapped students, parents will be urged to insist that each program for their child include: 1) the identification of a sequence of behaviors in terms of course objectives; 2) a statement of how well their child is now performing with respect to that sequence; 3) a target behavior within the sequence for each child and 4) a projected date when the child can be expected to demonstrate the target behavior.

The present authors believe that the use of well-defined objectives may enable a science teacher to evaluate each student, whether handicapped or not, more efficiently for prescriptive-instruction purposes. Criterion-referenced instruction may reduce the ambiguity regarding what kind of objectives should go into an IEP. A teacher should have little problem in finding guidelines for developing specific objectives for any science class (e.g., Popham and Baker, 1973; Hively, Maxwell, Rabehl, Sension, and Lundin, 1973; Price, Martuza, and Crouse, 1974).

Pyfer (1976) believes that to assess where a student is performing along such a continuum implies that norm-referenced testing may not be appropriate. To state that a student's performance on a test is below that of his/her peers does not provide the information sought. Identifying specific learning strengths and weaknesses is a criterion-referenced testing problem. Although Pyfer's continuum of skills dealt specifically with the psychomotor domain, it may serve as a basic model for individualized educational planning in general.

Public Law 94-142 provides a legitimate rationale for advocating criterion-referenced achievement testing as an integral part of science education programs for handicapped students. The IEP concept is a means for further integrating testing into the teaching system. The law in its entirety has implications which go far beyond the improvement of educational opportunities for handicapped students.

When a number of tests are used for assessing instructional needs, and end-of-course evaluation, the purpose and standard for each test should be carefully defined. In each application of the instruments and procedures, the IEP team needs to examine closely the educational and psychological costs involved in making incorrect decisions regarding student ability and achievement. Moreover, the need for reliable and valid evaluation instruments and procedures will increase in proportion to these costs.

A criterion-referenced framework of evaluation is philosophically more appealing to the testing and evaluation needs stated in recent federal legislation for improving educational opportunities for handicapped children. Yet, as Sapon-Shevin (1978) has pointed out, all children need appropriate educational planning, and to imply in any way that these are requirements only for handicapped students "is to perpetuate a senseless distinction, in this case at the expense of those students assigned to 'regular' education." We are apparently witnessing a significant shift toward a new paradigm in educational testing and evaluation; one focused on the individualization of evaluation rather than on selection and sorting functions; one which recognizes and takes advantages of the positive dimensions of both sameness and difference; and one which reflects a far-reaching and even more significant shift in societal attitudes.

Much anxiety arises as classroom teachers frequently perceive the IEP as an accountability measure that could be used against them if the student does not attain the specified annual goals or short term objectives. While they may not be held responsible for student attainment of the annual goals and short term objective, teachers frequently find themselves in situations where they are on-site observers and evaluators of the handicapped student.

With the changing times, it is no longer enough to know how to competently work with students and guide their learning. Teachers now need to be informed, knowledgeable, and responsible in assuring that they are providing an appropriate education for all students in the classroom.

The Science Test

Testing is one educational process which can provide teachers with a valuable tool for gaining useful information about the stage of a student's development. A test can also provide information important for the program that will nourish the student's abilities (Eyman, Brager and Barnes, 1977). Testing can uncover clues to significant behavior, interests, aptitudes and abilities which help to find solutions to problems. But tests are not magic. Tests provide us with just one method of discovering what students can do, how they learn, and how to keep them reaching forward.

As practitioners, most of us have probably wondered if our tests are measuring what we intended to measure. We also often ask ourselves whether our tests would give us the same estimates of our students' abilities if we gave the same test or an equivalent one over again. Although these statistical questions of validity and reliability have been extensively covered in published texts and measurement journals, the classroom teacher frequently lacks the training to use the theory effectively.

Because of the emphasis on relative achievement, tests have been developed for the purpose of spreading out test scores . The grading curve has become a common strategy for interpreting test performance in our classes. Within the contemporary science classroom, however, new methods of teaching science are enhancing learning for all students. Individualization, inquiry approaches, "hands-on" investigations, self-pacing, Piaget's theory, mastery learning, multi-sensory science instruction, and many other curriculum and teaching innovations have practically eliminated the myth that for test results to mean something, there must be a reference group of "slow" students, a reference group of "good" students, and some that lie between. By walking into the classroom with such a preconceived notion of achievement expectations, we serve only to perpetuate a self-fulfilling prophecy. For those of us genuinely concerned with teaching science successfully to all students, this normal-curve model is inadequate.

Many educators have described applications of criterion-referenced test theory to science teaching (Lang, 1981, 1983; Ludeman, 1975). Torop (1978), for example, described the Individual Learning System in Chemistry. Dziubian and Esler (1974) described Science-A Process Approach (SAPA) as a complete and extensively tested example of the use of criterion-referenced evaluation procedures in science. Criterion-referenced testing is also the evaluation framework for some national standardized tests in science. Saylor (1974) described the criterion-referenced procedures of the National Assessment of Educational Progress (NAEP) which includes the evaluation of science achievement. Tyler (1975) believes that the NAEP provides the public with a better grasp of what children and youth are learning by reporting the percentage of each group (9 year olds, 13 year olds, 17 year olds, and young adults) who know particular facts, and can perform certain skills.

The Iowa Tests of Basic Skills also provides a criterion-referenced skills analysis in more than 65 different skill areas, including science. The summary report indicates the number of items attempted, number correct, total number of items in the test form, and percent correct score for the student, in addition to both class and national norms for each skill. The Iowa Tests of Basic Skills are widely used to assess a range of instructional needs for each student, class, school, and even school systems.

Gray (1978) applied both criterion-referenced measurement theory and the developmental theory of Piaget to the assessment of human mental functioning. He writes that although the origins of the two theories are often regarded as mutually exclusive, they are, in fact, highly comparable in nature. From an *ex post facto* analysis of Biological Sciences Curriculum Study test data, he has developed a framework for constructing science tests for criterion-referenced and Piagetian[1] interpretations (Gray, 1973). This includes an interesting approach to the examination of item difficulty from the perspective of developmental psychology.

Doran (1980) has written an outstanding text on general trends in measurement and evaluation in science classes. Published by the National Science Teachers Association, the book includes discussions on the assessment of cognitive and affective outcomes, and the analysis of items and standards-setting procedures. The American Association of Physics Teachers has published, through the American Institute of Physics, a book of selected reprints entitled Achievement Testing in Physics. Professional journals in the area of science education have also shown that assessment and evaluation are prominent concerns. Science Education, for example, has published 186 articles dealing with science tests, assessment instruments, and evaluation of science programs (Champagne and Klopfer, 1978). More recently, the journal has initiated a series called Science Education Assessment Instruments (Klopfer, 1978). Wall (1981) has compiled a descriptive listing of forty-nine different standardized science tests for the elementary, middle/junior high, and high school levels. Wall's book includes a section on Tests in Braille and Science Tests in Larger Type.

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[1] A Piagetian interpretation would include an evaluation of a student's cognitive readiness to perform certain tasks. For example, does a student understand that changing the shape of a ball of clay does not change the clay's mass? If not, then from a developmental perpective, this child may not be ready to learn certain physical concepts.

Summary

Teachers are in the midst of an exciting era in education, an era with a new goal of giving every student an appropriate needs-based education. With respect to this goal, PL 94-142 recognizes that children with various types of disabilities require different approaches and, especially, that testing as well as teaching must be adapted to unique learning paces styles, and abilities. How can classroom teachers do a fair and accurate job of assessing a student's complex range of academic strengths and weaknesses? Modification, adaption, and adjustment must become the teacher's guideline for testing handicapped students. It is the present authors' intention to encourage further research and publication of findings relevant to testing handicapped students. The following chapters will provide the classroom teacher with helpful information for working toward an unbiased testing environment for all students.

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CHAPTER 2

TESTING VISUALLY IMPAIRED STUDENTS IN SCIENCE

Kenneth R. Ricker

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Should visually-impaired students enrolled in a science course be exempt from taking tests? Are tests less important for visually impaired students? Visually impaired students should not be excused from taking tests even though it may affect the complexity of the teacher's task of evaluating students. Visually impaired students should receive the same feedback information about their progress and overall achievement as the non-visually impaired students receive. Teachers also should gather this information as one means of assessing the alternative or modified instructional strategies that are being used with the visually impaired students. If alternatives or modifications are not being used, the data may indicate there is a need to use different techniques.

Double standards should not arise simply because a student has impaired vision (Gearheart and Weishahn, 1980). Double standards can ultimately lead to variations in the quality of education available within a school. For example, an educational institution recently excused a blind student from taking a qualifying examination required for graduation. The institution apparently did not wish to be bothered with making special arrangements for this student to take the examination. This meant the graduation requirements were different for the visually impaired student than for the other students. Such practices can lead to a meaningless diploma.

Determining an Appropriate Testing Technique

There are a variety of techniques that can be used by teachers to test visually impaired student in their classrooms. Several techniques are described in this chapter. Before teachers select an appropriate technique it is essential that they collect data to answer three questions.

First, what modality do the visually impaired students use most effectively in the classroom? Do the students have residual vision which they can use effectively; or do the students rely mainly on auditory input, tactile input, or a combination of these modalities? If the students have residual vision which they can use effectively, the teacher can consider using a visual testing technique. Otherwise, a non-visual testing technique has to be used.

Second, what is the content of the test? Is the test trying to assess the student's understanding of certain science concepts, or the student's ability to construct and interpret a graph or perform another process skill? The answer to this question will help ascertain what technique may be appropriate. Suppose the student can use either an auditory or tactile input effectively. The teacher may then consider giving a test to assess the student's understanding of certain concepts by tape (auditory technique) or by braille (tactile technique). However, if the test is designed to assess the student's ability to make a graph and then interpret it, a tactile diagram should be considered.

Third, what materials, devices and services are available? It may be impractical, or even impossible, for a classroom teacher to consider a specific technique if the necessary materials or services are not available. If a large print typewriter or enlarging machine is not available, then the construction of large print tests may be impractical.

Or if it is appropriate to use a braille test the teacher must have access to a volunteer brailling service unit in the community or professional staff services such as a resource teacher who can braille.

Once the teacher has answered these three questions, it will be easier to identify an appropriate testing technique. Three categories of techniques are discussed below: visual, auditory and tactile. It is important to remember that these categories are not mutually exclusive. A test may employ both auditory and tactile techniques. A specific technique also may not be used for every test for a student. A change in the type of test which the teacher gives may dictate a change in the technique that is most appropriate.

Regardless of the technique that is used, the factor of time needs to be considered. It will take more time for visually impaired students to complete a test. These students should receive enough additional time so they have the same opportunity as the non-visually impaired students to demonstrate their achievement. The amount of additional time that is given will depend on the type of test questions that are given and the technique which the students use to do the test. The decision-making process for determining the amount of time that will be allocated for the completion of a test should always involve the visually impaired students.

Visual Testing Techniques

This category includes the methods that are appropriate for use with students who have residual vision. These students have sufficient vision to use printed materials under certain conditions.

Usually people think only about enlarging regular size print so the visually impaired student can see it well enough to read it. However, there are other factors than the size of the print that can influence the ability of a student to read print (Harley, 1973). The quality and contrast of the print, as well as available illumination, may be more crucial than the print size for some students. The typical purple ditto test may lack sufficient quality and contrast for the student to read it. This condition may be eliminated by typing the test on cream-colored and non-glare paper with a typewriter that produces sharp and dark letters. For some students it may be necessary to alter the amount of illumination. While one student may need additional lighting, another student may be sensitive to light and need a reduction in the lighting in order to effectively read the test during the test period.

A variety of techniques are used to enlarge print size. Some students will have acquired the skill of using hand held magnifiers. It may be necessary for the teacher to promote the use of these devices, as well as other optical devices, since students may avoid using them in class situations. These students may try to avoid making themselves appear different, or acknowledge their visual problem, in a peer setting.

Large print typewriters and enlarging machines may be available for the teacher to use. Usually the print is enlarged to about 16 or 18 points (about twice the size of newspaper print which is 8 to 10 points). While some commercial tests are available in large print, this does not satisfy the need for large print teacher-made tests. And finally, there is the felt or fiber tipped pen technique. The test can be hand printed on cream-colored and non-glare paper.

In some schools closed circuit television systems such as the Visualtek may be available. When using this kind of system, the regular print material is placed under a camera. The student reads the print on the monitoring screen. The student can control the size, contrast, and brightness of the print appearing on the screen (Ricker, 1981).

As more schools introduce the use of mini-computers for instructional purposes in science, another avenue of testing becomes available. The test can be entered in the computer in such a way as to have it appear in large print on the screen. A unique value of using computers is the elimination of having the student make a written response to the test questions. To answer a question on the computer the student needs only to push a key. The student's answers will be stored so the teacher can recall them later for grading purposes.

Auditory Testing Techniques

Techniques by which the tests are read to the visually impaired student are probably the most commonly used method of test administration. However, it has the greatest potential of interfering with the goals of testing, since the test is being filtered through a third person. Whether the test is read to the student directly or via an audio tape, there is danger that the way in which the test is read may influence the student's responses. For example, the speed at which the test is read or the emphasis placed on certain words may affect the listener's interpretation of the question. The total meaning of a question may be lost if the question is read too slowly, particularly if it is a very long and detailed question. Or conversely a question might be read so rapidly that the student cannot assimilate all the details. Unconscious stress of a certain word may cause the listener to be distracted from the main concern of the questions, or misinterpret the question. For example, the following sentences contain the same words but can produce different meanings if read differently: "The plants are in the green house." or "The plants are in the greenhouse." Or, "He is a lighthouse keeper." and "He is a light housekeeper." In long questions the antecedents of pronouns such as it, they, this, and that can easily be forgotten or mistaken (American Foundation for the Blind, 1957).

When the test is read directly to the student, care should be taken that the reader only reads the questions, and is not asked to interpret the questions. The teacher must be careful to construct a test which does not confuse or mislead the students.

The reader should receive the test in sufficient time to review it, especially if it contains technical and scientific terminology. If the test includes graphs or charts the teacher should write down a description of the figure for the reader. This will prevent the reader from inadvertently giving the student either too much or too little information about the figure.

Some students work effectively if they can use a taped test along with a printed copy. This combination helps reduce possible misinterpretations of questions that arise from the way the questions are read.

With the emergence of voice synthesizers the need to use human readers will diminish in the future. Some schools already have reading devices such as the Kurzweil reading machine. The students can put a regular copy of the test on the machine to have it read electronically to them. If the students are not sure of the way the machine pronounces a word, the machine can be instructed to spell the word. The students can take the test privately and independently (Sensory Aids Foundation, 1978).

Voice synthesizers are also available for mini-computers. Visually impaired students may also take tests on the computer along with their non-visually impaired peers. The use of voice synthesizers with a test on a mini-computer which includes visual illustrations will need to be accompanied with tactile diagrams that correspond with the illustrations that appear on the screen of the mini-computer.

Tactile Testing Techniques

The most common tactile method for testing a student is through the use of braille tests. The teacher must have access to brailling services. These services are usually available in two ways: local volunteer brailling service units or by professional staff members. In order to have the test brailled by the test date the teacher should plan well ahead so there is ample time to have the test brailled. With computer produced braille becoming more common, this problem of time and obtaining services may diminish in the future.

It should be noted that the brailling of science tests may cause problems not encountered in brailling a test in non-technical subjects such as history. The commonly known braille code is used for literary English and would be used to braille a history test or a non-technical science test. There is another braille code for science and mathematics notation. Thus, if a chemistry test includes a lot of technical notation, it will require the services of a person certified to transcribe materials with this braille code. In addition, the student must be able to read this braille code. Unfortunately, this combination of factors will not be found in many school communities.

Another tactile technique used by some students employs the use of an Optacon. An Optacon is designed to convert ink print into tactile form. A small camera is moved across the ink print with one hand while a finger on the other hand is placed on a tactile array of vibrating rods. The image of the letter seen by the camera is reproduced on the tactile array. The reading finger feels this image. This means the student who uses an Optacon can read a regular print copy of the test. There is no need to have the test transcribed into braille.

The use of tactile diagrams and models is a critical factor in constructing many science tests for visually impaired students. A variety of ways exist for making diagrams and models which can be read with the finger tips. Raised line diagrams can be used to produce simple diagrams; and cut and paste methods can be employed to make more complex diagrams (Ricker, 1980).

Tactile diagrams and models can be used in a variety of ways. A student may be given a tactile diagram of a stage in mitosis to identify, or be given several diagrams of the mitotic process to put in the proper sequence. A tactile graph can be used to determine if the student can perform the processes of interpolation and extrapolation correctly. Problems involving the use of levers and pulleys can be illustrated graphically with raised diagrams.

A photograph of a tactile diagram is shown in Figure 1. The diagram depicts the action of three enzymes over a given pH range. The student can be asked to examine the diagram and then contrast the actions of these three enzymes. This type of raised diagram is made by using a vacuum forming process so multiple copies can be made from a single master copy (Ricker and Benefield, 1981).

If the classroom teacher is not going to introduce the diagrams to the student in the testing situation, the teacher should write out a description of the diagram for the reader. It is absolutely critical that the reader be able to indicate the meaning of the symbols that are used in the diagram or model. For example, suppose sandpaper is used to represent the spindle fibers and chain beads depict the chromosomes in a diagram on mitosis. The reader who may not even be familiar with the subject matter must be able to indicate to the student what these symbols represent in the diagram.

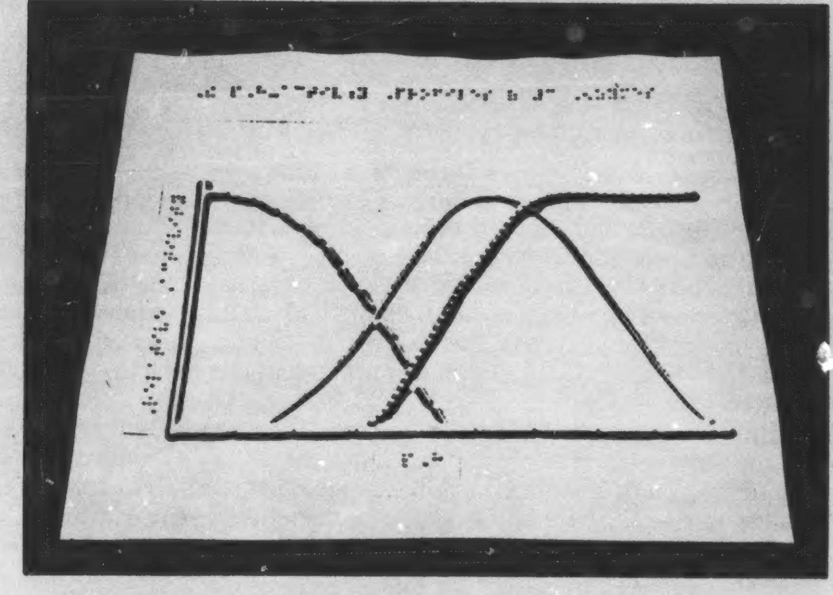

Figure 1: Tactile Diagram Used With Visually Impaired Students

Responding to Test Questions

Thus far, the discussion has focused on the techniques that can be used to communicate the test questions to the students. Before the testing procedure can be finalized, the methods by which the students can record their answers to the test questions must be considered. Some students may be able to write out their answers with soft heavy lead pencils or felt-type pens. This technique can be laborious for essay type answers. In some cases the student may be able to type out his answers to essay questions. For braille students the most effective technique may be to have students braille their answers. In this instance the teachers will have to ask another person to transcribe the answers unless they can transcribe braille. Some students prefer to braille their answers first and then type out the answers for the teacher.

An oral technique of responding to the test questions may be the most practical technique. The students can respond orally to a notetaker (teacher, resource teacher, or volunteer) or to a tape recorder. When a notetaker is used the person should record the response of the student without consciously reacting to the student's answer.

A special technique can be used to have a student show computational work in the solution of a science problem if a talking calculator is available. By having a tape recorder on when the student uses the talking calculator, it is possible to record the steps and calculations that the student makes. The teacher can use the tape to ascertain if an error is produced by lack of understanding of the procedure to be used or an error in calculations.

Some test items may require the student to construct a tactile diagram. For example, it may be necessary for the student to illustrate what happens in a certain event or to graph the results of a given experiment. Care must be taken that the test does not assess the artistic or creative ability of the student to construct a diagram. If there is any question about how to interpret the diagram, the teacher should ask the students to describe what their diagram depicts before an assessment of the answer is completed.

Laboratory Type Tests

Teachers also have to design non-verbal tests that involve the use of science materials. The objectives of many science programs include the acquisition of certain laboratory skills. For example, the students should be able to determine the mass of an object, or test a substance to ascertain if it contains starch. By using modified or special equipment it is possible to test visually impaired students to determine if they can perform these tasks. A light sensor can be used to modify an analytical balance so the student can calculate the mass of an object to the nearest tenth gram (Ricker and Benefield, 1981). By using a light sensor the students can use the iodine test to ascertain the presence of starch in objects.

Actually, the visually impaired students should have practiced these skills in the lab sessions. If the science course has lab sessions, the visually impaired students should be active participants. Both the use of special equipment (i.e., light sensor) and the modification of regular equipment will enable the visually impaired students to conduct most lab activities (Ricker, 1980). The lab test should be an extension of these lab activities, the same as it is for the non-visually impaired students.

Non-Teacher Made Tests

A variety of other tests are available to evaluate visually impaired students. Many of these are standardized tests, and include achievement, special aptitudes, intelligence and personality tests, and are generally administered by psychometrists. A description of many of these tests is provided by Scholl and Schnur (1978).

Some science textbook programs include tests that teachers can administer. If the teacher has such a program and needs these tests on tape, in large print or braille, the teacher should first check with the American Printing House for the Blind and Recording for the Blind, Inc. for their availability. While these agencies have many science textbooks available in these forms, they have only a few of the tests available.

Summary

A wide variety of techniques that can be used to test visually impaired students have been described. The specific technique that is used should try to eliminate as much bias as possible in the testing procedure. In other words, the visually impaired students should receive an equal opportunity to demonstrate their proficiency.

Two general questions that should be considered when selecting a testing technique are:

Question 1. What resources and services are available for constructing and administering a test?

Question 2. What is an appropriate match between the modality that the student will use and the content of the test?

Factors relating to specific testing techniques include:

(1) There are several ways by which regular size print can be enlarged.

(2) Care needs to be exercised so unbiased results are obtained when a reader or tape recorder is used to administer a test.

(3) The current availability of braille tests in which the science and mathematics braille code is used is limited.

(4) Tactile diagrams can be used to include graphs and drawings in a test.

(5) A lab test should employ only those procedures that the student had an opportunity to learn and practice in lab classes.

(6) A way, or combination of ways, that will enable the students to record their responses completely and accurately is essential.

Regardless of the technique that is used there is one factor that must always be considered—TIME. Teachers usually construct tests for sighted students to take in a certain amount of time. Practically every technique that is used with visually impaired students will mean that additional time should be allocated for the completion of the test. This does not mean an unlimited amount of time should be given. It does mean that an appropriate amount of additional time should be given so the students have an equal chance to demonstrate their competency.

A recent situation which a visually impaired person encountered when taking a bar exam illustrates this point in a negative way. The person was permitted to have a reader during the exam period. The person started the exam when everyone else did and had to stop when everyone else did. However, extra time was available during this time frame. The visually impaired student and the reader could skip the rest breaks given to the other people taking the exam! This approach causes one to wonder if breaks during an exam are desirable for sighted persons, why wouldn't breaks be desirable likewise for blind persons? Hopefully, science teachers will not use the philosophy illustrated by this approach in their classrooms.

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Sensory Aids Foundation. *Sensory aids for employment of blind and visually impaired persons: A resource guide*. New York: American Foundation for the Blind, 1978.

Addresses

American Printing House for the Blind
1839 Frankfort Avenue
Louisville, KY 40206

Recording for the Blind, Inc.
215 East 58th Street
New York, NY 10022

CHAPTER 3

TESTING HEARING IMPAIRED STUDENTS IN SCIENCE

Harry G. Lang

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Harry G. Lang

For years, many educators have used test scores to place hearing impaired[2] students into courses, or programs, while ignoring the implications of language difficulties for interpreting these scores and generalizing about student abilities. When age, grade, or other norms are used, the problem may be even more severe. For example, grade equivalent scores for hearing impaired students are usually on the lower end in science achievement since the items "are dependent on proficiency in standard English and illustrate difficulties most deaf students face in this sphere" (Moores, 1978). Woodward (1975) questions the use of norms for most tests used with hearing impaired students. She writes that we are often left with the uncomfortable feeling that even relatively encouraging test scores disguise vast areas of weaknesses. Scores obtained by hearing impaired students on standardized tests often do not indicate what the student knows; only how he/she compares with others taking the test. At best, we can ascertain the student's general age or grade level with respect to the norm group. When the norm group consists of both handicapped and nonhandicapped students, interpretations of test results may be made even more difficult. Even the science and other subtests of The Hearing Impaired Edition of the 1973 Stanford Achievement Test (SAT-HI) battery, now normed for hearing impaired students, are in need of much revision. Although the SAT-HI has been used for years, educators of the hearing impaired have only recently begun to assist the publishers with item format revisions.

Nor are these standardized achievement tests appropriate for use in measuring student mastery of objectives in particular science classes. Jensema (1978) writes that no achievement test, no matter how well constructed, can ever hope to measure academic ability with absolute accuracy. He stresses that those who routinely administer the same achievement test to students in order to measure change in academic performance are likely to be wasting both time and money. Currently available standardized achievement tests are usually not accurate enough for classroom use unless the teachers are following a precise curriculum for which the instruments were designed.

When teachers develop their own tests for use in their classrooms, test items must be carefully written for all students to clearly understand what is being asked. The language of the test items may be the determining factor in whether or not a student demonstrates mastery of the course content. This is especially true for the hearing impaired student. To assist with this problem, a brief review of relevant research will be provided in this chapter and implications for the science teacher will be made from the review.

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[2] Throughout this chapter the term "hearing impaired" will be used for students with moderate to profound hearing losses. Even students with mild hearing losses, however, exhibit many language difficulties and communication problems which warrant careful planning of the testing environment as described in this chapter.

Language Considerations in Testing the Hearing Impaired Student

Testing the hearing impaired student in science is a multidimensional problem. There are no reliable tests which can differentiate reasoning from the language needed for the demonstration of reasoning. The intricate and subtle connection between these two has escaped many educators. Furth (1966, 1973) has taken a Piagetian perspective, contending that there is no functional relationship between verbal language and cognitive development. Research has provided evidence which supports this belief. Watts (1979), for example, concludes that a lack of linguistic experience has no substantial impact on a deaf child's understanding of spatial transformation. The educational ramifications of these research studies are significant. Yet, the fact that some writers seriously question the use of pictures in teaching hearing impaired children (Van Uden, 1970) is disheartening.

When developing a test item for a science achievement test to be administered to a hearing impaired student, a number of language considerations should be made. Special precautions need to be taken in the use of vocabulary and certain syntactic structures of English. Quigley et al. (1976), for example, found that 18 year-old students still have problems understanding complex sentences. Long sentences should be broken down into single-clause structures where possible in order to allow better comprehension. In other words, reducing sentence complexity will enhance the intelligibility of test items. In the author's opinion, simplicity of sentence structure is a parameter of utmost importance and should be carefully considered by the science teacher who hopes to obtain valid estimates of a hearing impaired student's ability.

Deafness as a language handicap presents a formidable challenge to the hearing impaired reader even during leisure reading. The added pressure of time constraints during a testing situation will increase test anxiety. Whenever possible, reduce pressure by avoiding time limits for classroom mastery tests. Time is essential for the hearing impaired student to piece together the complexity and abstraction inherent in the test items. Only after such synthesis can the student attempt to respond to the task at hand.

The seriousness of the hearing impaired student's reading comprehension problems has been documented in numerous research studies (e.g., Cooper and Rosenstein, 1966; DiFrancesca, 1971). There is a dearth of literature on the relationship of reading ability to testing and test development for hearing impaired students, however. The literature is especially lacking in information which would help the classroom science or mathematics teacher with some practical recommendations. Although not dealing specifically with tests, Hargis (1969) discussed how reading difficulties may confound the assessment of problem-solving abilities. The average hearing impaired child achieves close to normal levels in arithmetic computation, for example, but when the numerical or quantitative problems are expressed as "word" or "thought" problems, the significance of language achievement becomes apparent. Hargis suggests sequentially ordered instruction and a careful grammatical approach to teaching the language aspect of arithmetic.

McKee and Hausknecht's (1980) review of the literature on the classroom assessment of hearing impaired students provides us with a discussion of syntax problems. They recommend minimizing the number of compound and complex sentences used in the test items and in the instructions for tests. This includes the use of relative pronouns, conjunctions, and complementation. Examples in Table 1 illustrate that the best approach to these problems, as a group, appears to be the breaking down of sentence structure for clarity and comprehension. Although it is felt that pronouns reduce redundant use of noun phrases, it is helpful to exercise caution, especially when several nouns are present in the sentence.

Table 1. Increasing clarity through simplification of sentence structure will enhance the validity of the test items used with hearing impaired students.

	More Difficult	Less Difficult
Relativization	Calculate the potential difference across the resistor R1, which is in series with R2, using Ohm's Law.	R1 and R2 are two resistors in series. Calculate the potential difference across R1. Use Ohm's Law.
Conjunction	In the following problem, describe the kind of image formed by a convex lens with the object at a distance less than the focal length, but do not calculate the image distance.	Below is a convex lens diagram. The object is at a distance less than the focal length. Discuss the image that the lens forms. Do not calculate the image distance.
Complementation	True or False: It is known that white light consists of many colors which can be separated using a prism.	True or False You can use a prism to separate white light into many colors.

The readers should not make the oversimplification from these examples in Table 1 that the number of words in a sentence alone determines its complexity. Passive and other complex structures can be embedded in a "short" sentence. For example, in the two sentences below, the second one may be more difficult for some hearing impaired students. The passive structure "formed by" makes this sentence more complex even though each sentence has seven words.

Describe the chemical reaction and the color.

Describe the image formed by the microscope.

Rudner (1978) describes several additional linguistic structures that are difficult for hearing impaired students. These structures include conditionals (if, when), comparatives (greater than, the most), inferentials (should, could, because, since) and low information pronouns (it, something).

The conditionals sometimes present problems in the development and scoring of a science test because the student may not realize that a statement in a part of a sentence is dependent on other information for its completion. They may read parts of the sentence in isolation. In the example below, a student may read the first part in isolation. Birds do have wings. The answer is False.

If birds had no wings, they could not fly. **True or False**

Although more research is needed to substantiate this, I believe hearing impaired science students have more difficulty with negative comparatives (less than, the least) than with positive ones (more than, the most). Inferentials appear to be misunderstood because they present complex time relationships. For example, the modal verb "would" is often used to refer to the future in past time as in the sentence below:

Ben Franklin thought that his experiment would succeed.

Low information pronouns may not be a serious problem if the antecedent is made clear to the student. The relative occurrence of the antecedent and the pronoun in the text or test item is quite important for comprehension. For example, in the sentences below, notice the close proximity of the antecedent (solution) and the pronoun (it):

Stir the solution. It will change color.

In some cases, it would be better to replace the pronoun with its referent noun at the beginning of the second sentence. This is shown below.

Add the powder to the solution. It will change color.

Add the powder to the solution. The solution will change color.

The inclusion of the referent noun may help some students understand that the solution, not the powder alone, changes color.

Further, certain connectives, such as therefore, moreover, nevertheless, accordingly, and respectively are more abstract than the conjunctions (and, but, so) and present difficulty in comprehension. These should probably be avoided unless a teacher wishes to present them in the context of mathematical logic. If this is done on a test, the teacher should verify that the hearing impaired students have been exposed to the connectives and that they are familiar with their meanings and uses.

In terms of interpreting achievement test scores, one must be cautious when generalizing about the hearing impaired student's ability and understanding of science concepts. The differences between scores of hearing and hearing impaired students may be a result of the hearing impaired students' educational experience, including a general lag in basic conceptual perspectives due to limited social opportunities and communicative interaction with family and peers. Austin (1975) links this lag in conceptual perspectives to language skills. Some of the science concepts tested on the instruments he used appear to include knowledge influenced primarily by practical experience. The learning of these concepts would not necessarily require formal language skills. Austin points out, however, that language skills are required to demonstrate this knowledge on written tests.

Item Format

LaSasso (1979) warns that drawing inferences about a hearing impaired student's comprehension of a passage from correct or incorrect responses to test questions is not as straightforward as it might appear. It is often difficult to assess whether the student has actually comprehended the test question itself. LaSasso's research provided some evidence that hearing impaired children found WH questions (those beginning with who, what, where, why, and how) significantly less difficult than questions using an incomplete statement. Examples of these two formats are provided in Table 2.

Table 2. WH format vs. incomplete sentence. WH questions appear to be less difficult for hearing impaired students.

More difficult: Incomplete Statement Format	Less Difficult: WH Format
The metric unit for mass is the __________.	What is the metric unit for mass?
a. liter b. kilogram c. meter	a. liter b. kilogram c. meter
The hottest location in our science classroom is ________________.	Where is the hottest location in our science classroom?
a. near the floor b. near the ceiling c. about 2 meters above the floor	a. near the floor b. near the ceiling c. about two meters above the floor

Garrison, Tesch, and DeCaro (1978) found that hearing impaired adolescents tend to agree rather than disagree with test questions written in a true/false format. They also described the difficulties hearing impaired students have in understanding negatives which are implied by comparisons or inferences. Although having negative connotations, the statement "Scientists should think more about the effects of their research on society" would be interpreted in a positive sense by many hearing impaired students. Double negatives also present problems. A sentence such as "It is not unusual to see lower energy consumption in warmer climates" will confuse many hearing impaired students. Double negatives should be used with great caution.

Little research has been conducted on the performance of hearing impaired students on true-false, multiple choice, and matching items. Comparative studies may prove valuable to test developers. Which type of test item proves most difficult for hearing impaired students? What are the linguistic and experiential factors inherent in these items? These questions have ramifications for both classroom, teacher-developed science tests, and standardized tests used for placement, college entrance, and/or employment.

In one study (McKee and Lang, 1982), no significant differences were found in the performance of hearing impaired physics students on equivalent true-false and multiple-choice test items. It was hypothesized that the unusual preference for multiple-choice tests expressed by the hearing impaired students reflected the more abstract nature of true-false items. The data, however, did not support this hypothesis. This study suggested the need for more definitive research on the format and syntax of test items.[3]

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[3] Those interested in statistical and research reports on testing hearing impaired students should write to the Office of Research and Development at the National Technical Institute for the Deaf and the Educational Research Laboratory at Gallaudet College.

Are our students learning in the science classroom? As teachers, we are concerned with the progress of our students and with making decisions about advancement, retention, or remediation based on their test scores. But what can we do when estimates of our hearing impaired students' achievement in science are clouded by our own inability to develop valid assessment instruments? What can we do to assure that teacher-developed tests are not linguistically or experientially biased? How do we know linguistic bias when we see it?

A test item is linguistically biased if a language handicapped student has mastered a course objective but is unable to demonstrate mastery because of syntactical or lexical factors. Although many hearing impaired students are language handicapped in standard English[4], there are plenty of students with normal hearing who demonstrate comparable lags in reading and comprehension abilities. Hence, those efforts made to provide accurate and fair teacher-developed science tests are bound to benefit the majority of students.

Experiential bias can also destroy the interpretability of test scores. Those students who have always lived in a ghetto will not have had the unique experiences of riding a snowmobile, being in a sailboat, or swimming in salt water. Those who have never heard a siren or pipe organ will have much difficulty answering test questions on such topics. These are cultural and acoustical experiences.

Experiential bias can also be language-oriented. Few of us who have studied French and are able to read and write it will easily grasp a pun or play-on-words in this foreign language. To a hearing impaired student, English used as such can be "foreign". English is "foreign" when it is used for lengthy test instructions or negative answers that are correct answers. English is "foreign" when test items include vocabulary never used before in the classroom. It is "foreign" when common words have more than one meaning and the test item is written to trap the examinee with a less sophisticated mastery of the intricacies of English. And clearly, a test is biased if hearing impaired examinees cannot appropriately respond to the items due to such linguistic barriers.

Administering the Test

Although we are aware that such factors as room layout, time of day, length of testing, number of tests given at one sitting, and even the type of print and the color of paper used for the test may be factors affecting performance, investigative efforts with regard to hearing impaired students have been few. The testing environment is as crucial to hearing impaired students as it is to those with other physical impairments. I am amazed at the number of people who perpetuate the myth that "deaf" people can work comfortably in noisy environments. Hearing loss may range from mild to profound. It may be a high frequency loss, low frequency loss, or a combination. Aural rehabilitation through amplification may often restore some hearing or at least sensitize the student to sounds in the immediate environment. These factors preclude the stereotyping of "deaf" individuals. Even a profoundly deaf student who receives no assistance from a hearing aid may be bothered by noise through vibrations in the floor or furniture. This should be an important consideration in the teacher's choice of a testing room.

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[4] Many hearing impaired students, though not all, have a primary language in American Sign Language (ASL). The uses of ASL in the classroom are only beginning to be explored, however.

Visual distractions also make it difficult to concentrate during testing. Avoid testing the hearing impaired student near a doorway where hall traffic may be distractive. Locate a seat where there is a minimum of motion or variation in lighting.

The importance of communicating the test instructions clearly cannot be overemphasized. Ideally, the test proctor should be able to communicate efficiently in the hearing impaired student's optimal communication mode. For some students, this will be American Sign Language. For others, it may be Signed English or another manual communication system. Still other students communicate primarily through lip-reading and the use of residual hearing. Levine (1974) identified twelve different methods for communicating with deaf examinees in her national survey of psychologists. The proctor should be aware of the communication needs and skills of the students prior to testing. Regardless of the method employed, the test instructions should also be in writing, either on the blackboard or written on the cover of the test. It may be helpful to check a few minutes after the test begins to see if the instructions were understood. A quick glance at the student's test may indicate a misunderstanding.

Deafness is often accompanied by other handicaps. Cerebral palsy or other motor control problems may be present. Many hearing impaired students also have vision impairments (Caccamise, Meath-Lang, and Johnson, 1981). When such is the case, other modifications of the testing administration may be necessary to provide non-discriminatory assessment. Again, the teacher must give careful thought to the establishment of a fair timing procedure to accommodate the special needs of the hearing impaired student.

The performance of a hearing impaired student on a laboratory practicum is dependent on these factors as well. Communication needs to be comfortable and efficient. Instructions for answering questions need to be clear and concise. For students with motor control problems, psycho-motor objectives should be evaluated with appropriate materials. Measuring the mass of a block of lead, for example, would be more appropriate than small lead shot when a student with cerebral palsy is being tested.

There are some educators and commercial test developers who have recently shown interest in hiring "signers" to sign the test items for the hearing impaired examinees. The underlying assumption is that the exam questions will be more easily understood when communicated through sign language. Extreme caution should be taken before experimenting with signed test items. There are many sign language systems now in use. These include American Sign Language (ASL), a manual language radically different from English, and manual systems that attempt to represent English, such as Pidgin Sign English (PSE), Sign English, Signed English, Siglish, Manual English, Seeing Essential English (SEE 1), and Signing Exact English (SEE 2). Lang and Caccamise (1981) provide a description of these systems with implications for the science teacher.

Those who experiment with signed tests must also take the receptive sign language skills of the examinee into account, the expressive sign language skills of the signer, and the fact that environmental conditions (ambient noise, lighting, etc.) may be confounding the testing process. If by "signer" is meant a certified interpreter knowledgeable of the code of ethics of the Registry of Interpreters of the Deaf and fluent in the examinee's manual communication system, there is much less risk involved. But if "signers" include those with inadequate skills in sign language communication, such efforts may be detrimental to the examinee's success on the test. In any case, the explicit permission of the instructor or those responsible for administering the test should be obtained prior to the testing. The hearing impaired student should have the opportunity, if possible, to meet with the person who will sign the test in order to provide some input on possible problems. Procedures should be clarified and little testing time will be wasted in communicating the mechanics.

McKee and HausKnecht (1980) write that the results of both basic and applied research furnish conditional support for the use of print for receptive communications by deaf persons. Until further research is conducted, the writer advises that signed tests be used only under carefully planned and evaluated circumstances. The individual student's communication competencies should be a significant factor in determining the method of delivering science test items.

Non-verbal Tests

In some cases non-verbal assessment of particular variables may be possible. A number of standardized tests used with hearing impaired students are in a "non-verbal" format and are used to evaluate intelligence, personality, and other variables (e.g., Vegely, 1971). Certain aspects of concept acquisition in science may lend themselves to non-verbal evaluation techniques. But, again, caution needs to be exercised. As Furth (1973) points out, a test is non-verbal if it does not require comprehension of verbal discourse as part of the procedure. Yet even non-verbal tests have the instructions presented orally. A picture-completion test may be used to evaluate a young deaf child's mastery of a science lesson. The child may not understand the examiner's instructions to "show me the missing part." Gestures and/or examples may also be necessary. In any case, the complexities introduced into the testing situation as a result of the deaf student's language problems are everywhere apparent. If teachers recognize that testing in general is an inaccurate science, and that linguistic bias only complicates assessment, the accuracy of their evaluation will be enhanced.

Summary

Teacher-made tests include those developed by a single teacher, by several instructors in one grade, or by a department. They are administered for the purposes of providing objective criteria for grading, concrete evidence of the student's strengths, and indications of weak areas where remediation is needed. Given these purposes of classroom testing, teachers should endeavor to make testing a valid process that is an integral component of the curriculum. Testing and evaluation is necessary if we are to be accountable for our teaching.

Making testing a valid process means making it accurate. Do our tests actually measure what they are purported to measure? This is a question of magnitude, especially when handicapped students are being evaluated. Evaluation is a broad concept, entailing the subjective interpretation of test scores. Value judgments are necessary. A degree of value judgment and subjectivity is also needed in planning the administration of the test. Classroom testing should be multifaceted. It should provide a diagnostic/prescriptive scheme for enhancing science education for each and every student.

In summary, suggestions for classroom teachers arising from the literature review include[5]:

(1) Whenever possible, avoid compound and complex sentences in test items and test directions.

(2) Caution students to carefully read the entire item (all options) before responding.

(3) Whenever possible, use visual aids to clarify discussions of test directions and items.

(4) Always include complete written instructions for the test.

(5) Use manual communication, whenever possible, to elaborate on the written instructions.

(6) Reduce test anxiety by avoiding pressure due to time limits.

(7) Sequentially order instructions with careful grammatical approaches.

(8) Avoid, whenever possible, use of relativization (which, whose, etc.) conjunctions, (but, and, etc.) and complementation (that, which, etc.).

(9) Use passive grammatical structures with caution (formed by, absorbed in, etc.).

(10) Be aware of the difficulty deaf students have with conditionals (if, when), comparatives (more than, the most, etc.) inferentials (should, could, since, etc.) and low information pronouns (it, something, etc.).

(11) Avoid negative comparatives if possible.
(12) Avoid, whenever possible, use of connectives such as "nevertheless, accordingly, respectively, moreover," etc.

(13) Keep in mind the role that acoustic experience plays in understanding puns (play on words), idioms, and "common" quotes.

(14) Be aware that deaf students are not always familiar with the multiple meanings of words.

(15) Avoid testing deaf and hard-of-hearing students in areas where visual or vibrational distractions may interfere with concentration.

(16) Be sensitive to each student's individual communication needs. Avoid stereotyping students as "manual", "oral", etc.

(17) Be aware that deaf students may also have visual or motor-control handicaps.

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[5] Several of these suggestions also appear in McKee and Hausknecht (1980).

(18) Learn to use interpreters efficiently.

(19) Keep in mind that even "non-verbal" tests require language and communication skills in the comprehension of the test instructions.

(20) Be aware that many deaf students interpret phrases in a linear fashion. Take this into account when developing test items.

(21) Keep to a minimum the number of test items in which the correct answer is a negative answer.

(22) Avoid generalizing that one test item format (e.g., multiple choice) is easier for deaf students. Research findings have not been definitive and further investigation is needed.

(23) Make sure that your deaf students are seated in positions that allow good visual reception of instructions and where they can easily catch your eye if they have questions.

(24) Frequent test errors from students who you know have mastered the material may indicate a problem with the interpretation of test items and directions. Watch for this during the first few tests you administer in your class.

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CHAPTER 4

TESTING MOTOR IMPAIRED AND ORTHOPEDICALLY DISABLED STUDENTS IN SCIENCE

E. C. Keller, Jr.

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E. C. Keller, Jr.

The problems of testing the motor impaired and/or orthopedically disabled individual are somewhat similar to those encountered when testing the sensory (vision/hearing) impaired. In many cases, the motor impaired/orthopedically disabled (MIOD) student can be helped with mechanical or prosthetic devices which replace or supplement the non-functional or missing parts of the body.[6] This is not so with certain speech deficient individuals, however. As with hearing impaired and visually impaired individuals, the degree of affliction and the age of onset have significant influences on the assessment of the abilities of MIOD students in science (as well as in other fields of study). The fact that many MIOD individuals are also sensory impaired leads to a generalized projection that the MIOD student population is quite variable in regards to functional abilities related to testing. Motor impairments and orthopedic disabilities range from the minor restrictive use of a limb, to extensive quadriplegic paralysis, to missing limbs. Since sensory deprivation is also possible, the wide range of disabilities makes difficult the task of generalizing about modifications of the testing environments and supplying appropriate suggestions for altering teacher-made tests and testing environments. For testing to be efficient, it is imperative that one establish a testing environment that is as unbiased as possible to the group of individuals being tested. This is just as true for the teacher-made test as it is for standardized tests. This chapter will focus primarily on facilitative techniques for testing the MIOD student in science.

The Breadth of the Problem

Depending upon the degree and site(s) of the affliction, minimal to extensive modification of the test environment will be needed[7]. The extremely wide array of motor and orthopedic disabilities results from a myriad of causes which can result in a wide range of limitations. For example, arthritis based disabilities can range from mild discomfort to painful swelling and inflammation of the joints. The life function limitation[8] of this disease can range from very little to quite severe limitation in the use of hands, arms, legs, etc. A moderate limitation may, for example, result in very slow writing. With more severe limitations, writing may even be impossible. However, a remote testing environment (at home or in an institution) may be necessary if the severity of the disability warrants it. Most alterations and strategies for testing the MIOD student fall somewhere between these two extremes.

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[6] The acronym MIOD was chosen by the author to include both the motor impaired and the orthopedically disabled. In many cases the functional limitations are the same for these two general categories of disability in terms of preparing for, and taking, teacher-developed tests. MIOD is not intended to be another "label", but rather an acronym to enhance the readability of this chapter.

[7] The test environment includes the test instrument or process, the immediate surroundings, and the supervision (assistive) aspects of testing procedure.

[8] By life function limitation, I refer to the ability or inability of individuals to function in their environment. An example of a life function limitation would be the inability to feed oneself.

Another example of motor impairment is spinal cord involvement which can result from either a congenital problem (e.g., spina bifida, osteoporosis, scoliosis) or can be of an adventitious cause such as diseases like polio, multiple sclerosis, and muscular dystrophy. Spinal cord involvement may also be caused by trauma, resulting in paraplegia, quadriplegia, or hemiplegia. There is a wide range of physical impairments which can produce a large array of disabilities. In these cases changes in the test environment may or may not be needed.

Missing (amputated) or deformed (e.g., thalidomide caused) extremities also lead to many different kinds of orthopedic disabilities which may require test environment modifications.

Brain involvement resulting from disease (stroke, rheumatic fever, etc.) or of congenital derivation as in cerebral palsy (CP), or epilepsy, can cause afflictions which may also indicate a need for special arrangements for classroom testing. For instance, a petit mal epileptic seizure may have the outward appearance of daydreaming. A grand mal seizure will be much more disruptive to both the student and the class. The instructor needs to react correctly with respect to immediate treatment. Although there is little the instructor can do to prevent disruption of the test environment with a grand mal seizure, preparation will minimize the disruption.

The diversity of motor and orthopedic handicaps undoubtedly suggests a large series of modifications and facilitative techniques to achieve equality in testing. However, this diversity does not necessarily imply expensive electronics, mechanical devices, or extra personnel. In most cases, logical and simple innovation and common sense, can mitigate[9] most problems. Since the student's family has already encountered some of these problems, assistance from both the student and his family is recommended. There are some students who will need specialized assistance in testing and, in most cases, assistive devices will already have been identified (and probably be in use) prior to the student's enrollment in a public school or a college/university environment. Generally, there is also a need for teacher orientation with respect to: 1) the student's special needs, 2) the use of necessary assistive device(s), and 3) the general methods of achieving equality of testing between both disabled and non-disabled students.

Testing bias for MIOD students manifests itself most seriously in formative and placement testing, since the assessment of the student's progress and placement decisions are based upon the results of such testing. Further, summative testing might lead to erroneous conclusions that a course or program should be revised due to the poor performance of MIOD students. In both instances, it is possible that the poor performance of such MIOD students is the result of biased testing. Connor (1967) reported that the intelligence levels of children in classes for the orthopedically disabled (excluding those with brain damage) did not differ from that of the total school population. These findings were supported in later studies by Nemarich and Velleman (1969). However, Nemarich and

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[9] Mitigation refers to the processes, strategies, or facilities modification which singly, or in combination, will alter the testing environment to bring about equality in the testing of a MIOD individual.

Velleman with their 30 home-bound, motor impaired children found that even though the intelligence levels were similar to non-disabled students, the home-bound children had "severe academic limitations" and were several grade levels below their non-handicapped peers across a breadth of subjects. Apparently, the home-bound training was not adequate to maintain the academic levels of in-school peers.

How does one approach testing a MIOD student? The first aspect of comprehending and solving the problem is to understand the disability in terms of specific limitations, since it is only through an understanding of the limitations in the testing environment that effective mitigative action can be realized.

The Need to Assess Life Function Impairment

One of the first considerations in the effective testing of a MIOD student is an understanding of his impairment and the true degree of limitation it causes in testing. Only through this means can a set of mitigative testing strategies be derived that are unique and fully appropriate to that particular student. Gaining an understanding of a student's impairment and testing limitations can be difficult, however. As Calhoun and Hawisher (1979) note, "the combination and permutation of levels and types of motor impairment plus the number and levels or related disorders are limitless."

There is a traditional classification of MIOD individuals: orthopedic conditions, muscle system impairment, and neuro-muscular disorders (White, 1978). Orthopedic conditions primarily affect the skeletal system, the joints, and the connective tissue (e.g., tendons and ligaments); muscle system impairment involves only muscle tissue; and neuro-muscular disorders concern the non-sensory aspects of the central nervous system, i.e., brain, spinal cord, and speech impairments. This system, however, does not provide a thorough understanding of the nature of the student's disability and is much too limited to be used in describing the functional range of MIOD needs for mitigative purposes. A related problem is that people who rely on the traditional classification tend to think generally in terms of the degree of disability (profoundly deaf vs. partial hearing) rather than in terms of what particular individuals are capable or not capable of doing.

A functional system of characterization is therefore used. This is the Life Function Impairment Assessment System (Dudek, et al., no date). By defining disabilities in terms of function, this system gives the instructor a much better insight into the actual limitations caused by the disability and makes it much easier for the instructor to select appropriate mitigative testing strategies for each student.

The life function impairment system recognizes five categories of functional impairment:

1) Health - refers to the physical and physiological functioning of the individual.

2) Mobility - refers to operating and negotiating in the physical environment.

3) Communication - refers to sending and receiving communications with people and the environment.

4) Congnitive/Intellectual - refers to interpreting events, learning, and applying learning.

5) Social/Attitudinal - refers to regarding oneself positively and interacting successfully with others.

This assessment system furthermore provides for the possibility that an individual with a particular disability may have difficulty (with varying levels of severity) in more than one of these categories. For instance, a hearing impaired individual can also have health disabilities (such as brain disorders), mobility problems (such as poor balance), communication problems (such as hearing and speech deviation), cognitive and intellectual problems, or social and attitudinal problems (social isolation and lags in social/emotional development). Also, one individual can have functional impairments stemming from more than one disability, for instance, impaired hearing coupled with an orthopedic problem. A life function impairment assessment system patterned after Dudek, et al. (no date) is presented in Table 3.

TABLE 3. GENERAL RELATIONSHIP BETWEEN TYPES OF FUNCTIONAL IMPAIRMENTS AND LIFE FUNCTIONS[10]. IN USE, THE CELLS OF THE TABLE WOULD BE FILLED IN WITH SOME INDICATION AS TO THE DEGREE OF IMPAIRMENT FOR THE INDIVIDUAL STUDENT BEING ASSESSED.

	General Disability Areas				
Life Function	Motor/ Orthopedic	Behavior	Chronic	Auditory Disease[11]	Visual
Health	[12]				
Mobility					
Communication					
Social/ Attitudinal					
Cognitive/ Intellectual					

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[10] This table is after that given in the Technology Assessment Report "Human Rehabilitation Techniques" by R.A. Dudek et al., Texas Tech. Univ.

[11] For example, emphysema or diabetes.

[12] The rating given in each cell reflects the degree of potential functional impact that could exist between a disability area and the life function of a disabled person. In practice, the assessment would be completed for just one individual as has been done in Table 4.

A table such as this can be used by school personnel to consider carefully the student's disability (or disabilities) in terms of the five categories of functional impairment.

Although we believe that some form of life function assessment should be completed for each disabled student no formal life function impairment assessment (after Dudek, et al., no date) for sensory impaired students is included. This is primarily due to the fact that there is an overriding need to assure that communication strategies are appropriate and in place for the hearing and visually impaired. The wide variety of life function limitations of the MIOD category of students (as compared to the sensory impaired students) precludes such a specific system of sensory assessment. Therefore, the more in-depth life function impairment assessment is required for the MIOD student.

Sample Assessment

Below is a brief example of how the life function impairment system could be used to develop appropriate mitigative strategies for a particular student. The student has spina bifida and is, for the most part, wheelchair-bound. He is a high school sophomore interested in engineering. The assessment of this student, which is shown in Table 4, indicates only one general health problem. He also has high mobility limitations, a few communication problems, some social/attitudinal problems, and a moderate degree of cognitive/intellectual problems (probably not directly associated with his disability). The instructor would probably focus first on the mobility aspects in planning his mitigative testing strategies along with consideration of the minor health problems. The assessment would alert the instructor to the student's behavior, some of the problems could be related to the student's disability and some to other causes, perhaps including a previous lack of home and classroom discipline.

Two other brief assessments of disabled students are outlined below. The first is a student with moderate to severe arthritis and with difficulty in the movement of the joints, careful observation of the student's performance of motor tasks would be a necessary supplement to examining the student's medical records?[23] It might be determined that the student's impairment in mobility is of such magnitude that it will "control" the other strategies. The impairments in the other four categories could be overshadowed since they are relatively low or non-existent. Some behavior problems might result from the high level of pain. The instructor, sensitized to the mobility problem, would have little or no difficulty taking appropriate mitigative measures. Possibly, educational modification would only be necessary in situations in which prolonged standing or walking were required.

The last example assessment is for a MIOD student who has severe cerebral palsy (CP). His assessment would be very different from that of the student with arthritis. Although cerebral palsy affects individuals in different ways, it is likely that a severely disabled student with CP would have extensive needs in most or all of the five life function categories. Because impairment of mobility could be high, the instructor would need to consider physical access to the testing environment. The student would probably

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[23] Student medical records are generally available to only medical or nursing staff. A teacher might need to consult such individuals for medical information.

TABLE 4 AN EXAMPLE OF LIFE FUNCTION LIMITATION ASSESSMENT OF A SPECIFIC MALE SPINA BIFIDA STUDENT.[13] RATINGS IN CELLS INDICATE THE DEGREE OF PROBLEM TO BE ENCOUNTERED.

	General Disability Area				
Life Functions	Motor/ Orthopedic	Behavior	Chronic Disease	Auditory	Visual
Health	Some Problem [14]	Some Problem [15]	No Problem	No Problem	No Problem [16]
Mobility	Severe Problems [17]	Some Problems [18]	No Problem	No Problem	No Problem
Communi-cations	No Problems	Some Problems [19]	No Problem	No Problem	No Problem
Social/ Attitudinal	Some Problems [20]	Some Problems [21]	No Problem	No Problem	No Problem
Cognitive/ Intellectual	Several Problems [22]	No Problems	No Problem	No Problem	No Problem

[13] This example assessment is for a specific student that we worked with. This example is NOT a general assessment for all students with spina bifida.

[14] Use of urine bag is a necessity - must schedule time for emptying.

[15] Urine odor problems may generate avoidance behavior by the student.

[16] Glasses corrected, for far vision.

[17] Most of the time this student is wheel-chair bound, he can use crutches for short distances and can transfer to a chair or bench from his wheelchair.

[18] "Aggressive" use of wheelchair - this can be a problem for other students.

[19] Inappropriate use of vulgar language. Disruption of class with outbursts and unrelated information.

[20] The student has great difficulty making and keeping friends - interpersonal relations are difficult for him. Urine odor problems may generate avoidance behavior by peers.

[21] General lack of self-discipline and respect for authority.

[22] There is a problem of depressed grades, but the student has an average I.Q., there appears to be no indication of an association of these cognitive/ intellectual facts with the disability; however, he was a home-bound student through the 4th grade.

be using a wheelchair, ramps, or an elevator to enable him to enter the classroom or laboratory and perhaps low laboratory benches.[24] Because of communication impairment, a reader or writer or some other input/output procedure would probably also be necessary during testing. Moreover, the amount of time necessary for testing would have to be evaluated and carefully gauged.

Other Considerations

After consultation with medical personnel, with parents, and with the student, the initial guidelines for the testing environment can be established. The initial testing strategies to be employed for a MIOD student can be discussed and agreed upon. There are certain tests which can be administered to assist in defining the optimal and least restrictive test environment for a given student. An example of such a test is the Bender-Gestalt Test which may be used to evaluate perceptual motor behaviors (Foster *et al.*, 1977).

Administration Techniques

Written, oral, tape recorded, or signed forms of a test instrument might be utilized as deemed appropriate. A reader, typewriter, interpreter, amanuensis[25] or other output (or recording) techniques may need to be used for assurance of unbiased testing. The administrator of such a test (if not the instructor) should also be familiar with the mitigative testing strategies to be used.

Inventory of Specific Impairments

In Table 5 is presented a check list of items for MIOD students (modified after Rusalem, 1962) that should also be considered as an integral part of the evaluation of the test environment. This list is not intended to be exhaustive, but rather a presentation of the types of information that are required in order to identify unique needs in the testing environment. Many modifications in testing will be similar to those needed in the instructional environment for the MIOD student.

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[24] Recently, tilting/stand-up adjustable height wheelchairs (with hydraulic jacks) have become available for non-ambulatory students in laboratories with stand-up height benches (Blumenkopf, Swanson, and Larsen, 1981).

[25] An amanuensis is a person who facilitates the taking of a test. The person is more than a "recording" secretary, but may be called upon to assist in both the input and the output aspects of testing.

Table 5. Non-Sensory Impaired Functional Capabilities for Use in Guidance in the Modification of Testing for MIOD Students.

Speech Articulation
- Adequacy for classroom and testing use
- Use of speechboard

Writing
- Capability of writing classroom notes
- Capability of dictating notes
- Has typing skills
- Capability of writing on a chalk board

Language
- Capability of communicating in the classroom
  1) Spoken
  2) Written notes
  3) Electronics (e.g., speech synthesizer)

Manipulation
- Capability of handling laboratory equipment safely
- Capability of writing using pen or pencil
- Capability of using chalk in classroom
- Capability of using calculator
- Capability of carrying own books and calculator
- Capability of turning pages
- Capability of steady hand movements
- Capability of two-handed coordinated movements
- Capability of picking up gross objects
- Capability of picking up fine objects
- Capability of typing movements (fast/slow)
- Capability of raising hand for instructor's attention
- Capability of manipulating papers

Mobility
- Capability of travel on level surfaces
- Capability of walking up and down stairs
- Capability of walking up and down outside slopes
- Relative speed of mobility
- Steadiness and balance
- Ability to sit in and rise from a chair

Attention Span
- Short time attention span for testing (seconds/minutes)
- Fatigue from sitting (hours); need for rest period(s)

In the assessment of a student, certain psychological data may also be utilized in diagnosing the student's verbal skills, performance skills, and knowledge levels. A preliminary educational assessment should also include personal interests, personality characteristics, native intelligence, eye-hand coordination, dexterity, and manipulative skills (Foster, Szoke, Kapisovsky, and Kriger, 1977). Such psychological/dexterity testing must be conducted with caution, especially with the more severely disabled individuals. A psychologist or psychometrician should be consulted in the interpretation of the test scores since the presence of motor, sensory, or perceptual impairment will probably influence the student's performance on standardized tests. Bias in testing culturally disadvantaged students has long been recognized (see, for example, Tyler and White, 1978). White (1978) reports that the content of some test materials depends upon unimpaired physical experiences for "correct" standardized responses. Further, Linde and Patterson (1958) reported that the realistic experimental responses of a group of CP adults were scored incorrectly because their experiences were quite different from those of the non-handicapped population for whom the test had been "written." Szhlenoff (1974) reports that "a palsied child may consider walking to the store an insurmountable task, while a physically intact youth might take such an action for granted." Garrett (1978) concludes that a great advantage in the standardized testing of the MIOD student is the taking of the test as a clinical tool in itself. The purpose would be to observe the MIOD student's behavior while taking the test. The observer would note, for example, how the student reacts to the various test tasks, the student's reaction to failure, the persistence in spite of uncoordinated, spastic, or difficult movements, and the use of hands. The observer can gain considerable insight into many aspects of the student's limitations in testing, including fatigue, persistence, and adaptability. Further, the degree of impaired motor coordination, control, and hyperactivity/hypoactivity can be assessed.

Accessibility

Accessibility is very important to the unbiased testing of the MIOD student. As discussed above, the severity of the disability dictates both the type of facilitative action and the extent of modification needed in the testing environment. The two major components of accessibility are the nature of the disability (as can be defined by the process outlined in Table 3), and the degree of affliction (which can be assessed through observation of the student while taking tests). Of the various aspects of the life function impairments illustrated in Table 3, the social/attitudinal aspect of life functioning does not appear to be as serious a problem for the "average" MIOD individual as it is with other disabilities. Mobility, however, is usually a very important accessibility problem. The student needs to be able to get to the testing area, whether it is a standard classroom, a field location, or a fourth floor laboratory. Additional planning and effort may be required for reaching the classroom for testing purposes. Certain afflictions can also interfere with testing. For example, the individual may be unable to remain in a sitting posture for more than an hour. An individual with CP may not be able to maintain eye fixation on a test item for more than a few seconds. Communication with the teacher may also be a problem for motor impaired students. Through the use of systematic assessment[26], the teacher can obtain the necessary information to focus on specific strategies required for an individual student.

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[26] By systematically observing the student in a variety of testing situations (short answer, true-false, hands-on practicum, etc.), the instructor can usually identify the optimal mode of test taking for the specific disabled student.

Another aspect of accessibility concerns the physical facilities for the educational environment. These are usually the first items to be identified and modified (widening doors, building ramps, lowering laboratory benches, etc.) The success of any such modification on the test environment can be easily measured. Most often these modifications involve the selection of a testing (and teaching) room which the student can enter. An examination in the field would pose the same problem as that of teaching in the field. Hence, if a ramped or elevator van were used to access the field site for instruction, the same mode of operation would be used for the testing situation and can be easily assessed. Accessibility problems in testing psychomotor skills in science (use of a sextant, for example) will be readily evident in the training session. Consideration must be given to elimination of possible testing bias attributable solely to the student's lack of the appropriate psychomotor skills. The teacher or another student could operate the sextant at the instruction of the MIOD student (Keller and Keller, 1978). Extreme caution must be used in this case, since explaining how to do something and actually doing that task are not necessarily the same, especially where a skill is involved.

Facilitation through mechanical devices and prostheses can also significantly alter the functioning of the MIOD individual in the testing environment and; in reality, any testing limitation assessment should be performed with the full range of the student's facilitative devices and strategies. But in some situations, the devices may introduce new problems. For example, a quadriplegic student may use a telemanipulator for communication or may require only a simple hand adaptor, or saddle, for holding a pencil. The telecommunicator may work very well in the student's home or institutional environment, but may not be operational in the testing environment. The existing degree of adaptation and facilitation might be quite sophisticated, but not useful in the traditional teaching/testing environment. Remote testing and teaching may be the optimal solution in some cases. From the previous discussion, a hand saddle does not present such a problem as does the telecommunication system. Unfortunately, not all MIOD students can use a hand saddle as their sole facilitative device.

Those MIOD students who also have sensory (sight or hearing) limitations will require an appropriate blend of facilitative devices or strategies to assure a completely accessible and unbiased testing environment.

From this discussion on accessibility, it might seem that the testing environment for MIOD students would be a complex melange, but this is not actually the case. Often, a simple leather hand saddle, a ramp, or a tape recorder are all that is needed to provide for an unbiased test environment. It should be stressed that, in some cases, because of the vast range of functional limitations, the testing environment might need to be more extensively modified.

The Time Factor

It may take a longer period of time for many MIOD students to complete tasks. Where testing is involved, the time factor is usually critical in assuring a valid assessment of skills and knowledge acquired in a course. White (1978) lists many authors who report that in order to obtain meaningful test results one must not give timed, continuously administered tests to those MIOD individuals with sub-par strength, coordination, or stamina - especially for paper and pencil tests. Instructors typically give "10 minute quizzes" or "50 minute exams". Built into these quizzes and examinations are time/task domains of a "reasonable" schedule for completion based on the teacher's personal experience. This time scale may be completely unreasonable for a student with a motor impairment or an orthopedic disability. The fingers of a MIOD student often move at a much slower rate than those of non-disabled peers. Words are formed much more slowly. The student may have no problems with the context, content, or problem solving aspects of the exam, quiz, or task, but the lack of motor control may make it impossible to do the expected work in the specified time period. It is not the writing, verbalizing, pointing to, or listening to the answers/responses alone which are of concern here, but also the amount of time for reading or listening to the test information which must be carefully assessed. In order to determine the optimal and equitable time frame for test input and output, trial observations, as suggested previously, are necessary.

If the examination were of a practical nature (e.g., a laboratory practicum), the time required for the MIOD student to shift from one station to another could be considerably more than that for non-disabled peers. In a practicum, the type of response might also be a very time consuming process for the MIOD student. A student with an upper-extremity handicap might require more time, for example, in setting a pointer under a microscope to a specific cellular inclusion. Also, more time might need to be provided for equitable reading of test directions or questions and for the student response. Time is a very critical aspect in making the test environment fair. Time is frequently overlooked in mitigative efforts in program accessibility for the MIOD student.

How does an instructor assess such special needs for an appropriate amount of time for the MIOD student? One method is to involve the student in the educational planning process. By following an observational method such as the one outlined previously, the instructor can ascertain additional needs or, for example, revise the initial guidelines/agreements outlined in the educational plan or pre-class arrangments. Mutual efforts by the instructor and the disabled student will evolve and an unbiased system will result from such efforts. For example, suppose a student does not finish the exam in the allotted time. If, through observation, the instructor confirms that the student was working continuously and diligently and that the answers given were, for the most part, adequate on that portion of the test completed, then a rational conclusion would be that the student realistically needed more time to complete the test. On the other hand, excessive test time must be avoided; a proper balance is needed. The original estimate of time needed for the MIOD student could also be determined from the observations and experiences on preliminary or standarized tests, taken with peers. These observations could be followed by teacher/student discussions about test timing. Former teachers may be able to offer helpful suggestions. There is, however, no simple solution or simple formula to follow. An individual assessment and subsequent rational judgment by the instructor is required.

Mitigative Strategies

It is beyond the scope of this chapter to discuss the removal of architectural barriers even though this is a critical factor in making the testing environment barrier-free for the MIOD individual. The student must obviously get to the test environment. Many information sources for removal of architectural barriers exist (Robinette, 1976; Dissertive, 1971; Architectural and Transportation Barriers Compliance Board, 1977) and will not be presented here. This chapter has stressed the point that mitigative action will vary both among students with the same type of disability and among individuals with different impairments. Some individuals will require no modifications, others a great deal (Keller, 1979). The extent of mitigative activity is highly dependent upon the interactions of many factors, including the severity of affliction, type of affliction, nature of life function impairment(s), age of onset, previous experience in test situations,[27] the extent to which rehabilitative efforts allow the individual to compensate for physical limitations, and the efficacy of medication. Table 6 provides a partial list of mitigative testing strategies. Additional information on strategies for testing can be found in White (1978) and Foster, et al. (1977).

There are four general categories of classroom science testing: 1) written classroom tests (true/false, multiple choice, essay, short answer, etc.); 2) oral or signed classroom tests(seminar, report presentation, etc.); 3) practicum laboratory tests (identification, demonstrations, etc.); and 4) practicum field tests (identification, demonstration, etc.).

As an illustration of the general testing situations given above, consider a student with a severe upper extremity limitation (paraplegic). The mitigative strategies necessary for each category of testing will be briefly explained: Assuming no problem in the input communication of the test, for the first category, an amanuensis or tape recorder could serve as the output device for communicating answers to the instructor. In the second test situation, no facilitation would be required (perhaps only someone to assist in turning pages of a report being given orally). In the third testing situation, some form of assistance would be necessary depending upon the extent of identification or demonstration. In identification, very little assistance would be required. For a demonstration, a fellow student or the teacher would perhaps need to perform the actual operations upon receiving the instructions from the MIOD individual. Finally, in the fourth type of testing, assistance may be needed to get the student to the test site, and then the mitigative strategy would be the same as that for the third testing category above.

For the remainder of this chapter, one could proceed through the almost endless combination of life function limitations of MIOD individuals including multiple sensory impairments. Instead, in Table 6 are listed several examples of life function limitations and a series of alternative mitigative testing strategies which could be used. This is not a complete listing, but provides a general illustration of some testing strategies that are available.

Summary

The problem of the equitable and unbiased testing of MIOD students in science is compounded by the complex nature of the types and degrees of severity of affliction along with the wide variety of testing options and environments available. Yet, it is precisely this variety of options and environments which makes the non-discriminatory, unbiased testing of MIOD students possible. There is no special talent required to devise and assure unbiased testing. It is necessary, however, that the instructor have an understanding of the life function limitations of one's disabled students. Some creativity will be needed in achieving the right combinations of mitigative strategies; and patience on the parts of both teacher and student is essential. The decisions made by teachers, regarding testing could very well influence a MIOD student's access to higher education and the aspiration toward a career in science. In each of our lives, there has been at least one understanding, creative, and patient teacher who has left an indelible mark on our person. Your handicapped student may very well consider you to be that special person.

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[27] Testing anxiety is a condition which is usually considered to be a function of the examiners' attitude towards the person taking the test (White, 1978). However, in one experimental program designed to reduce test anxiety in disabled clients of a rehabilitative center, no significant difference in test scores were observed (Vernandos and Harris, 1973).

Table 6.

Possible Mitigative Testing Strategies for the MIOD Individual. These Strategies Are Listed by Primary Limitation Only. Combinations of Life Function Limitations Will Require Corresponding Combinations of Mitigative Testing Strategies.

MIOD Limitation	Possible Mitigative Testing Strategies
Lack of or minimal use of arms/hands	Selection of non-manual types of tests; use of adaptive prosthesis; instuctions (from student) on how-to-do test task (in practicum, for example); specially designed answer sheet (larger answer areas or conversion to T/F or multiple choice); use of amanuensis; hand saddle for pencil; oral responses; use of tape recorder for responses; use of lap board on wheelchair; substitution of larger items for smaller items in practicum; more time.
Lack of or minimal use of legs	None for most testing. In field or laboratory testing, would need to facilitate access.
Lack of or minimal use of arms and legs	Combination of above strategies.
Non-vocal	Manual language board; use of T/F and multiple choice items; more time; response to oral or written test items by blinking, head nodding, or pointing; use of hand voice (voice synthesizer); modified electric typewriter; use of Bliss symbol communications (symbols represent language components); minicomputer (voice synthesizer, typed output, or TV screen display).
Speech Defects	More time plus non-vocal strategies (as above) as required.
Neurological (specifically for those students who are highly distracted)	Lower light levels; shorter test time periods; wearing of ear phones (muffs) during test period; removal of distractive visualization.

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Afterword

The authors would like to summarize this book by pointing out several underlying assumptions not stated explicitly in their respective chapters. There are, of course, commonalities which we are sure our readers have noticed. The classroom teacher needs to be knowledgeable about and sensitive to a disabled student's physical limitations and how they functionally impact on test-taking. The concommitants of a disability (e.g., language lag or cultural deprivation) are as important as physical limitations. Disabled students experience unnecessary "handicaps" when teachers are not aware of these functional limitations as they relate to learning and test-taking.

Secondly, the principles and recommendations outlined in this book may be appropriately applied to multiply handicapped students. A legally-blind deaf student, for example, may need assistance with large-print tests and clear language in the instructions and test items. Similarly, the hearing-impaired student with cerebral palsy may need, in addition to communicative assistance, more time to work with problems which call for psychomotor skills.

Third, while this book considers testing as a means of evaluation, the authors feel that testing may also be a learning experience for handicapped students. Not only do the handicapped students have an opportunity to demonstrate their achievement, but they also have an opportunity to acquire and practice skills that may enhance their repertoire for solving future challenges.

We encourage teachers to work closely with the disabled student in the identification of individual needs. Parents and resource room personnel may also be invaluable in providing teachers with further insight into
equitable, nondiscriminatory testing.

Appendix A

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Appendix B

Organizations and Agencies

Organizations and Agencies

Alexander Graham Bell Association for the Deaf, Inc.
3417 Volta Place, N.W.
Washington, D.C. 20007

American Academy for Cerebral Palsy
University Hospital School
Iowa City, IA 52240

American Association for Rehabilitation Therapy
P.O. Box 93
North Little Rock, AR 72116

American Association for the Advancement of Science
1776 Massachusetts Avenue, N.W.
Washington, D.C. 20036

American Association of Workers for the Blind
1511 K Street, N.W.
Washington, D.C. 20005

American Council of the Blind
1211 Connecticut Avenue, N.W.
Suite 506
Washington, D.C. 20036

American Epilepsy Society
Department of Neurology
University of Minnesota
Box 341, Mayo Building
Minneapolis, MN 55455

American Foundation for the Blind
15 W. 16th Street
New York, NY 10011

The American Humane Association
Hearing Dog Program
5351 S. Roslyn Street
Englewood, CO 80110

American Physical Therapy Association
1156 11th Street, N.W.
Washington, D.C. 20005

American Printing House for the Blind
1839 Frankfort Avenue
Louisville, KY 40206

American Speech and Hearing Association
9030 Old Georgetown Road
Washington, D.C. 20014
Association for Education of the Visually Handicapped
919 Walnut Street
Philadelphia, PA 19107

Association for the Education of Teachers in Science
Old Dominion University
Norfolk, VA 23508

Association for the Visually Handicapped
1839 Frankfort Avenue
Louisville, KY 40206

Better Hearing Institute
1430 K Street, N.W.
Suite 600
Washington, D.C. 20005

Bureau for Education of the Handicapped
Office of Education
400 Maryland Avenue, S.W.
Washington, D.C. 20202

Clearinghouse on the Handicapped
Office for Handicapped Individuals
338 D Hubert Humphrey Bldg.
200 Independence Avenue, S.W.
Washington, D.C. 20201

Closer Look
Parents' Compaign for Handicapped
Children and Youth
Box 1492
Washington, D.C. 20013

Convention of American Instructors of the Deaf
814 Thayer Avenue
Silver Spring, MD 20910

Council for Exceptional Children
1920 Association Drive
Reston, VA 22091

Dialogue with the Blind
3100 South Oak Park Avenue
Berwyn, IL 60402

Epilepsy Foundation of America
1828 "L" Street, N.W.
Washington, D.C. 20036

ERIC Clearinghouse on Exceptional Children
1411 South Jefferson Davis Highway
Arlington, VA 22202

ERIC Clearinghouse on Science, Mathematics, and Environmental Education
The Ohio State University
1800 Cannon Drive
400 Lincoln Tower
Columbus, OH 43210

Hadley School for the Blind
700 Elm Street
Winnetka, Illinois 60093

Foundation for Science and the Handicapped
E.C. Keller
College of Arts and Sciences
West Virginia University
Morgantown, West Virginia 26506

Library of Congress
National Library Service for Blind and Physically Handicapped
1291 Taylor Street, N.W.
Washington, D.C. 20542

Muscular Dystrophy Association of America
810 7th Avenue
New York, NY 10019

National Amputation Foundation
12-45 150th Street
Whitestone, NY 11357

National Association of the Deaf
814 Thayer Avenue
Silver Spring, MD 20910

National Association of the Physically Handicapped
6473 Grandville Avenue
Detroit, MI 48228

National Braille Association
645A Godwin Ave.
Midland Park, NJ 07432

National Association for the Visually Handicapped
3201 Balboa Street
San Francisco, CA 94121
or
305 East 24th Street
New York, NY 10010

National Center for Deaf-Blind Youths and Adults
105 5th Avenue
New Hyde Park, NY 11040

National Center on Educational Media and Material for Handicapped
371 Arps
1945 North High Street
Columbus, Ohio 43210

National Easter Seal Society for Crippled Children and Adults
2023 West Ogden Avenue
Chicago, IL 60612

National Federation of the Blind
218 Randolph Hotel
Des Moines, IA 50309

National Foundation - March of Dimes
800 2nd Avenue
New York, NY 10017

National Multiple Sclerosis Society
257 Park Avenue, South
New York, NY 10010

National Paraplegia Foundation
333 N. Michigan Avenue
Chicago, IL 60601

National Science Teachers Association
1742 Connecticut Avenue, N.W.
Washington, D.C. 20009

National Society to Prevent Blindness
79 Madison Ave.
New York, NY 10016

Recordings for the Blind
215 East 58th Street
New York, NY 10022

Science for the Blind
Box 385
Wayne, PA 19087

Science for the Handicapped Association
Ben Thompson
SSS 200 Eled. 102-055
University of Wisconsin-Eau Claire
Eau Claire, Wisconsin 54701

The Howe Press
Perkins School for the Blind
Watertown, Massachusetts 02172

United Cerebral Palsy Association
66 E. 34th Street
New York, NY 10016

United Epilepsy Association
111 W. 57th Street
New York, NY 10019

Appendix C

Glossary of Terms

Glossary

ACADEMIC APTITUDE	Native and acquired abilities needed for doing school work.
ACCESSIBILITY	The free and unobstructed access to a location, activity, or any other aspect of the educational environment.
ACHIEVEMENT TEST	A test that measures the extent to which a person has learned certain information (both quality and quantity of work).
AFFECTIVE	Related to feelings or emotions.
APTITUDE TEST	A test which measures an individual's ability (native or acquired) to learn particular skills.
AMANUENSIS	One who is employed to write from dictation, to copy what another has written, or to record lecture or other educational activities.
ASSESSMENT	Collecting information about a student's academic strengths and weaknesses, levels of functioning and learning characteristics.
ATTENTION	The ability to focus with eyes and/or ears for some period of time.
AUDITORY INPUT	Information received through the sense of hearing.
AWARENESS	Having knowledge of something through observation or by interpreting what one sees, hears or feels.
BEHAVIORAL OBJECTIVE	Statement of what a student will be able to do in measurable terms. Example: James will be able to accurately explain photosynthesis in his own words.
BIAS (TEST)	Partiality or prejudice resulting from the way test items are stated or illustrated. A biased test item usually favors certain examinees in the test-taking group who are more likely to answer correctly because of prior experience.

BRAILLE	A form of tactile readings consisting of raised dots arranged in a cell. A cell may contain one to six raised dots and represent a letter, word, part of word, composition sign or punctuation.
BRAIN INVOLVEMENT	Pertaining to functions of the brain.
CLOSED CIRCUIT TELEVISION	Self-contained television system that enables user to magnify printed material electronically. An example of a CCTV is the Visualtek.
COGNITIVE	Having to do with thinking, understanding. Being able to use judgement and memorizing.
COMPENSATE	To make up for. Example: When a person is born blind, (s)he learns to compensate for the loss in vision by using other learning channels (ears, touch) more efficiently.
COORDINATION	Ability to use a part of the body in combination with other parts to complete a task.
CORRELATION	Relationship between two scores or measures.
CRITERION-REFERENCED TESTS	Tests which show what a student can or cannot do. They compare a student not to other students but to a set of standards or objectives. Tests to measure a student's own progress. CRTs provide an absolute measure of student performance.
DEGREE OF INFLICTION	The severity of the disabling condition (as in partially blind vs. totally blind).
DEVELOPMENT	Stages of growth from birth through adulthood. The approximate ages at which stages in development occur are charted in "developmental scales." Generally, development is measured in the following areas: Fine Motor: Movement in smaller parts of body, such as grasping and using fingers. Gross Motor: Large muscle and body control and coordination (head control, sitting, crawling, standing, walking, etc.) Cognitive: Ability to think, reason, and to solve problems.

Social-Emotional: Growth in self-concept and social skills.

Language: Growth in ability to understand and communicate through:

- expressive language: Communicating verbally by using words, writing, or gestures.
- receptive language: Attaching meanings to words, based on experience.

Career: Awareness of relationships among interests, abilities and the world of work.

DEVELOPMENTAL LAG OR DELAY	A delay in the appearance of a stage of development in any of the above areas.
DIAGNOSTIC TEST	Test which diagnosis areas of weakness and strength. Diagnostic achievement tests are used in reading, arithmetic, and other areas to evaluate a student's performance and to prescribe instruction based on areas of weaknesses and strengths.
DISABILITY	Any restriction or lack (resulting from an impairment) of ability to perform an activity within the manner or within the range considered normal for a human being.
EDUCATIONAL GOAL	The level of educational achievement accepted as reasonable and desirable for a specific student at a specific time and at a specific rate of speed.
ETIOLOGY	The cause or origin of a handicapping condition.
FUNCTIONAL LIMITATION	Any restriction or lack of ability to perform a functional activity.
GRAND MAL SEIZURE	An attack of epilepsy in which there are severe convulsions and loss of consciousness.
HANDICAP	A disadvantage for a given individual (resulting from an impairment or a disability) that limits or prevents the fulfilment of a role that is normal, depending on age, sex, social, or cultural factors, for that individual.

HAND ADAPTOR	A prosthetic device which fits over the writing hand for holding a pencil. Some devices are made of leather and wood; others of light metal and leather or plastic.
HEMIPLEGIA	Paralysis of one lateral half of the body or part of it resulting from injury (hemorrage or disease) to the motor centers of the brain.
HYPERACTIVITY	Excessively active.
HYPOACTIVITY	Conspicuously less activity than normal in a child.
IMPAIRMENT	Any loss or abnormality of psychological, physiological, or anatomical structure or function.
INDIVIDUALIZED EDUCATIONAL PLAN	A written agreement among teachers, parents and the student about the learning experiences the student needs.
INPUT	Any information coming in through the ears, eyes, nose, sense of touch, body movement, or through tasting.
INTELLIGENCE	Ability to understand through experience. The ability to apply this understanding in the future to solve problems and make judgements.
INTEREST INVENTORY	Test in which a person records, in an organized manner, his likes and dislikes in a number of different situations.
LIFE FUNCTION IMPAIRMENT	Relating to those limitations in the functional aspects of an individual's day-to-day activites. The concept as used in this book refers to those functional limitations related directly to the process of preparing for and taking a teacher-made examination.
LIGHT SENSOR	A device which produces an auditory signal that varies in pitch and volume when exposed to varying intensities of light.
MANUAL COMMUNICATION	A global term which includes a variety of sign codes, fingerspelling, and American Sign Language (ASL)
MANUAL EXPRESSION	Using the hands and other parts of the body to be able to show the use of some object.

MASTERY LEARNING	A general theory that favorable conditions can be developed which will enable all (or almost all) of the students to attain a previously established standard.
MITIGATION	Refers to the alteration of an educational strategy or technique such that the student's physical disability becomes less a factor influencing the amount of learning that occurs.
MULTI-SENSORY	Using many senses (seeing, hearing, feeling, tasting, smelling).
NORM	Statistical term which describes the performance of some specified group. "Norms" indicate normal, usual, or average performance.
NORM-REFERENCED TEST	Test which compares a learner's performance to a norm (an average). A test which provides a relative measure of student performance by comparing this performance with other students taking the same test.
OBSERVATION	Systematically watching and recording facts, data, behavior.
OBJECTIVE TESTS	Tests in which a single answer is correct. Scorers have no option as to rightness or wrongness of answer.
OPTACON	A device which converts ink print into a tactile form on an array of vibrating pins.
PARAPLEGIA	Paralysis of the lower half of the body involving both legs usually due to disease or injury to the spinal cord.
PETIT MAL SEIZURE	A milder form of epilepsy in which there are short attacks of unconsciousness without convulsions.
POINT TYPE	A system to measure the size of type print. There are 72 points in type that is an inch high. Large type materials are commonly 16 to 18 point type.
PRACTICUM FIELD TEST	An examination which is given in a field site, usually where learning previously occurred. e.g.: Identification of plant species in a forest.

PRACTICUM LABORATORY TEST	An examination which is given in the laboratory and which is usually of a hands-on nature. It is usually given in the same site as the laboratory learning experience. e.g.: Identification of a specific type of tissue in a plant or animal cross-section by use of a microscope.
PROFILE	A graphic representation of the results of a test or several comparable tests. A profile is useful in identifying general areas of strength or those needing reinforcement.
PROSTHESIS	An artificial device to replace a missing part of the body (as a suction socket to replace a lower leg, or a dental restoration).
PSYCHOLOGICAL TEST	A test used for studying people and how they behave. May be intelligence tests, personality tests, or other tests to decide if there may be an impairment of functioning.
QUADRIPLEGIA	Paralysis of both arms and legs.
RANGE	The difference between the lowest and highest scores on a particular test taken by a particular group.
READING MACHINE	An electronic device that converts ordinary printed material into spoken English. The Kurzweil Reading Machine is an example.
RESIDUAL VISION (HEARING)	The remaining vision (hearing) which a person possesses.
SADDLE	(same as hand adaptor)
SPINAL CORD INVOLVEMENT	Pertaining to functions of the spinal cord.
STANDARDIZED TEST	A test given to a group of students under uniform conditions, with the same instructions, time limits, etc.
SUBJECTIVE TEST	Test in which different answers are possible. There is no set answer key. Example: essay test.
SUB-TEST	Many tests are broken down into parts. The results of a sub-test may be used by itself in a battery of tests.

TACTILE DIAGRAM	A diagram which is raised so the reader can observe it with the fingertips.
TALKING CALCULATOR	A hand-held calculator which gives oral output for each entry and result.
TELECOMMUNICATOR	An electronic device whereby an individual can communicate outside of his personal environment by voice or by signal.
TELEMANIPULATOR	An electromechnical device used to perform a mechanical function and controlled by voice, muscle, blowing, etc.
TESTING ENVIRONMENT	A global term which includes the test instrument, the location where the test takes place and its physical characteristics, the group of examinees taking the test along with the disabled student, and the person's administering the test. If facilitative devices or support services are used, these are also part of the testing environment.
VALIDITY	The extent to which an instrument measures effectively what it is designed to measure.
VOICE SYNTHESIZER	A device which produces synthetic speech sounds through electronics.